VISION GUIDELINES[1]

I. INTRODUCTION

These guidelines serve as an update to the 1985 POST Vision Screening Guidelines. Although both editions address many of the same visual acuity issues, this update provides a more in-depth, literature-based approach to the evaluation of visual function, consistent with the type of guidance found throughout the rest of the Medical Screening Manual. This additional depth and detail is intended to enable physicians and hiring authorities to establish vision standards that are fair and consistent, and to allow for the individualized consideration of agency and candidate specifics.

A. PRE-EMPLOYMENT VISION SCREENING AND THE LAW

The importance of vision to the safety of the officer and the public is undisputed, yet pre-employment vision standards have been the subject of many legal challenges. Most commonly, agency vision standards have been assailed for: (1) lack of proven job relatedness; (2) failure to allow for reasonable accommodation; (3) inconsistency in standards across agencies; and (4) inconsistent enforcement of standards within an agency, particularly with respect to candidates versus incumbents.

1) Insufficient Job Relatedness. Not uncommonly, an agency's selection of vision standards is based on unsubstantiated suppositions rather than on research demonstrating job relatedness. The vision guidelines presented here are supported by detailed, quantitative summaries of the currently available literature. However, it is incumbent upon each agency to review these summaries as carefully as the guidelines themselves to ensure that the assumptions and findings are applicable to the job duties and circumstances in its jurisdiction.

---

[1]Authors: R. Leonard Goldberg, M.D. (City of Los Angeles); Shelley Weiss Spilberg, Ph.D. (POST)
Specialist Review Panel: Ian Bailey, O.D.; James Bailey, O.D.; Michael Gordon, M.D.; Chris Johnson, Ph.D.; James Sheedy, O.D.; Stephen G. Weyers, M.D.

Publication Date: July, 1994

Note: These guidelines reflect the combined input of the vision expert panel; however, the viewpoints of individual panelists are not in all cases identical to the positions described herein.

2) Failure to Allow for Reasonable Accommodation. Another frequently adjudicated agency vision policy is the unilateral prohibition against the use of a visual correction device or procedure to accommodate poor visual acuity (e.g., glasses, contact lenses, radial keratotomy). Findings in favor of the candidate in these cases are not uncommon when the agency appears to have based its policy on unfounded concerns rather than factual evidence. Included in this section is a detailed discussion of the advantages and risks associated with each method of visual correction, along with guidance on how to use this information to make appropriate employment decisions.

3) Inconsistency in Vision Standards Across Agencies. While patrol officers across the state share many essential job functions, differences in job demands and environmental conditions do exist across agencies. Thus, the risk posed by an officer with decreased visual function (or the hardship caused by accommodating such individuals) may also vary across agencies. Throughout this section, the impact of site-specific factors are discussed to enable each jurisdiction to create vision standards that are appropriate for its specific agency.

4) Inconsistent Enforcement of Agency Standards. An agency's allegation that its vision standards are job-related is weakened if incumbent officers who no longer meet these standards are successfully performing the job. While at times judges have agreed with law enforcement agency assertions that experience can partially compensate for visual impairment (e.g., Padilla v. City of Topeka, 1985), other courts have ruled against law enforcement agencies who maintain stringent vision standards for applicants while failing to enforce these standards among its incumbent officers (e.g., Brown County v. LIRC, 1985). However, the stability of most visual functions makes this double standard issue largely moot. Except for near vision, the visual acuity of the vast majority of persons remains fairly stable with age. As evidence, the results of uncorrected vision testing among incumbents of the Los Angeles City Fire Department (Goldberg & Bible, 1993) showed that, after an average of 11 years of service, over 96% of the 1,111 firefighters tested still possessed uncorrected vision that met the pre-placement guideline of 20/40. Even in the class of Captain II, about 90% of the 164 incumbents still had 20/40 vision after an average of 23 years of service.

In summary, the intent of the research presented in this chapter is to enable agencies to develop reasonable vision standards which can both minimize safety risks and fair employment liability.

B. OUTLINE OF HIGHLIGHTED CONDITIONS

1) Far Acuity Deficiency

   - Use of glasses
   - Use of contact lenses
   - Use of orthokeratology

2) Radial Keratotomy

3) Visual Field Deficiency

4) Binocular Fusion Deficiency

5) Color Vision Deficiency

A summary of the recommended evaluation criteria presented in this chapter begins on page XI-57.

C. IMPLICATIONS FOR JOB PERFORMANCE

In 1984, POST conducted a vision-oriented job analysis for the position of patrol officer (Briggs, 1984). After interviewing and observing officers in the field, a panel of vision experts developed a list of 17 relevant visual skills. The importance of these skills for patrol officer performance was then rated by 158 incumbent officers (average patrol experience = 5 years) who had been shown slides depicting and illustrating each of the 17 visual skills. The officers were also asked to provide detailed accounts of actual critical incidents based on their personal experiences. The officers produced a total of 1,291 incidents which involved at least one of the 17 visual skills. The results from both activities are reported in Table XI-1.

As indicated in Table XI-1, the officers rated dark adaptation as the most important visual skill, followed by peripheral vision. However, no skill was rated less than "important." The ability to identify objects was involved in the highest percentage of critical incidents (24.9%), followed by visual pursuit (21.1%), motion detection (17.9%), dynamic far acuity (15.6%), dark adaptation (15.5%), and peripheral vision (11.2%).

The usefulness of these results for establishing quantitative screening guidelines is limited by the large number of visual skills assessed, their interdependency, and (for many of the skills) the unavailability of practical tests for their measurement. Nonetheless, these results confirm the importance of virtually every visual capability in the safe performance of patrol officer duties.

TABLE XI-1
Patrol Officer Importance Ratings of 17 Visual Skills (N = 158)

Visual Skill	X̄ Importance Rating*	% of the 1,291 Critical Incidents in Which Skill Was Involved
Dark Adaptation	4.50	15.5%
Peripheral Vision	4.34	11.2
Identify Objects	4.29	24.9
Motion Detection	4.13	17.9
Fine Details/Various Light Levels	4.03	9.1
Pursuit	3.95	21.1
Dynamic Near Acuity	3.93	2.5
Accommodation	3.87	4.3
Dynamic Far Acuity	3.81	15.6
Depth Perception	3.68	6.8
Light Adaptation	3.63	3.3
Glare Recovery	3.61	1.1
Glare Tolerance	3.59	9.8
Identify Large Forms	3.54	1.1
Static Far Acuity	3.54	3.8
Color Identification	3.53	5.8
Color Discrimination	3.30	1.2

*Rating scale values: 5 = critically important, 4 = very important, 3 = important, 2 = of some importance, 1 = of little importance

From Briggs, R. 1984. Visual skills job analysis and automated vision testing. Unpublished technical report for the Commission on Peace Officer Standards and Training.

II. MEDICAL EXAMINATION AND EVALUATION GUIDELINES

A. GENERAL SCREENING RECOMMENDATIONS

1) History:

All candidates should be questioned regarding use of glasses or contact lenses, visual loss, night blindness, refractive surgery and eye diseases (see Appendix C - Medical History Statement, Form #2-252).

2) Routine Testing:

a. FAR ACUITY

It is very important to use standardized charts and methods when measuring visual acuity. Non-standardized testing results in erroneous measurements and increased measurement variability.

Far acuity testing procedures:

1. Use only charts which meet ANSI Z80.21 (1992). To date, the Bailey-Lovie chart and the ETDRS chart meet this standard (Ferris, et al., 1982).

2. The chart should have relatively even luminance (brightness) across its surface - luminance should be 160 cd/m^2, with an acceptable range between 80-320 cd/m^2.[2] This brightness can be accomplished by placing the chart immediately next to a window with moderately filtered light (e.g., arranging blinds so that direct sun does not hit the chart). Make sure that the candidate is not looking towards a window with direct sunlight that serves as a source of glare. In an otherwise darkened room, a 100-watt light bulb in an auxiliary lamp holder at about 2.5 feet from the chart will also provide this luminance level. Most fluorescent lit rooms, unless they are highly lit, will require some auxiliary lighting to accomplish 160 cd/m^2.

3. Testing should be performed with the candidate at a distance of 20 feet from the chart. If the candidate is unable to discern the top row of letters at this distance, testing should be performed at 10 feet and the measurements adjusted appropriately (e.g., reading the 20/40 line at 10 feet is equivalent to 20/80).

4. Monocular testing should precede binocular testing.

5. Uncorrected acuities should be measured before corrected acuities.

6. The candidate's eyes should be carefully inspected to ensure that contact lenses are not worn during uncorrected testing.

7. An occluder should be used by the candidate on one eye while testing the other eye. The candidate can hold the occluder. The occluder can simply be an index card.

8. Candidates should be informed that they may not squint during the testing. The tester should observe the candidate to ensure compliance.

9. Candidates should read at least one acuity line in which they can identify all 5 letters. They should proceed to successively smaller acuity lines until they are unable to identify any letters on a line. They should be encouraged to guess when letter recognition becomes difficult.

10. Candidates should be given credit for each letter properly identified. The best method of scoring is to record the number of letters properly identified on each line attempted.

---

[2] This is equivalent to 25-100 foot-candles.

11. Visual acuity is scored by identifying the acuity line which was closest to being properly identified, and including a +/- notation to more precisely convey the number of letters properly identified. For example, if the candidate properly read the entire 20/30 line and one additional letter on the 20/25 line, the score would be 20/30+1. Identifying all of the 20/30 line and 3 of the 5 letters on the 20/25 line would result in a score of 20/25-2. Since the charts mentioned above have 5 letters per acuity line, the +/- value will never exceed a value of 2.

12. In scoring visual acuity, letters which are properly identified on a smaller line compensate for letters missed on a larger line. For example, if a candidate reads 4 out of 5 letters on the 20/30 line, and 2 of 5 on the 20/25 line, the score would be 20/30+1.

13. Measured acuity should meet or exceed the agency standard. For example, if a standard has been set at 20/40 then the measured acuity must be 20/40 or better (20/40-1 does not meet the standard).

b. COLOR VISION

A pseudoisochromatic plate (PIP) test should be administered to all candidates.

It is crucial that the test be administered under proper illumination conditions. All color vision tests are designed to be used with a standard source of illumination, one approximating standard illumination "C" of the CIE (International Commission on Illumination). <u>Neither daylight nor incandescent lighting should be used. The standard illuminant should be the only source of illumination</u>. However, illumination provided by ordinary daylight fluorescent lamps (15-watt type, providing 25 foot-candles of illumination) is a minimum substitute for CIE standard daylight with the Ishihara PIP plates. Better options include Hi-Lite fluorescent bulbs, the True Daylight Illuminator (available through Richmond Products), and the Verilux True Color Light fluorescent tube (F15T8VLK), available from Verilux Incorporated. A recent study by the Federal Aviation Administration (Milburn & Mertens, 1993) demonstrated that the inexpensive Verilux tube is an effective substitute for the now unavailable Macbeth Easel Lamp.

Tinted lenses effectively alter the standard illumination required for all color vision tests, thereby invalidating the results. <u>Therefore, use of colored contact lenses (such as the X-Chrom) or tinted spectacle lenses should not be permitted for color vision tests</u>.

Before administering the test, make sure that the candidate, test, and illuminant are properly positioned. The candidate should be seated a distance of 75 cm. (about 30 inches) from the test. The PIP plates should be supported and then tilted until they are perpendicular to the candidate's line of sight. The illuminant should be situated so that the illumination is direct and even, and is incident approximately at an angle of 45° to the plates. It is desirable to have a small paint brush available for use as a pointer or for tracing symbols, numbers, or winding paths on the plates.

Before beginning, explain the testing procedures to the candidate; for example: "I am going to show you some colored numbers in this book. On each plate, you will see a one or two digit number, or none. Tell me what you see. If you are not sure, use the paint brush to trace over it."

Testing should begin with the presentation of the demonstration plates. If the candidate cannot read the demonstration plates, discontinue the test.

Present the remaining plates in steady, rapid succession. No more that 3-5 seconds should be allowed for a response to each plate.

Mark the plates which were read incorrectly on the score sheet and then determine if the total number of test errors exceeds the pass-fail standard established by the test publisher.

c. BINOCULAR VISION - STEREOPSIS

All candidates should be administered a binocular vision test. Candidates should be tested while wearing their visual correction (e.g., glasses, contact lenses). There are several satisfactory commercial tests available, such as the Titmus Industrial Screener, that are relatively inexpensive, easy to use, and readily available.

3) Examination:

Routine physical examination of the eyes is discussed in Chapter IX - Neurology. However, during the examination of the cornea, special attention should be given to detecting radial keratotomy incisions. In most cases, incisions can be readily detected using the +20 lens of the ophthalmoscope (black numbers) to focus on the cornea.

B. EVALUATION OF COMMON CLINICAL SYNDROMES

1) FAR ACUITY DEFICIENCY

a. GENERAL CONSIDERATIONS

Various methods have been used to determine the impact of far acuity deficiencies on performance as a patrol officer. The critical patrol officer functions studied include: (1) deciding whether to discharge a firearm; (2) facial recognition; and (3) license plate identification.

1. "Shoot-No-Shoot" Decisions: Deciding whether to discharge a firearm is one of the most critical tasks facing patrol officers. Unfortunately, in a number of jurisdictions, making this decision is not all that infrequent. For example, in 1986, approximately 1 out of 50 LAPD sworn officers discharged their weapon; 42% of these incidents resulted in a civilian being wounded or killed (Pate & Hamilton, 1991). Since this study included officers who do not work in the field, the firearm discharge rate among officers assigned to field duty would be expected to be higher.

   A separate study of LAPD officer-initiated shootings during 1990-92 found that over 30% of the 519 incidents occurring during this period involved shooting at targets over 25 feet away. Moreover, 65% of officer-initiated shootings took place at night or at dawn/dusk (Spilberg, 1993).

   An officer's ability to rapidly determine whether a suspect in the distance is holding a weapon is typically studied by using decorrection lenses in scenarios at distances varying from 7-25 yards. In a 1981 study by Giannoni, six California Highway Patrol (CHP) officers with 20/20 or better uncorrected vision were sequentially decorrected to 20/40, 20/80, and 20/200. During each visual condition, the officers were asked to identify whether a "suspect" was holding a gun or a comb at distances of 7, 15, and 25 yards. No errors were made with 20/20 vision, even at a distance of 25 yards (Table XI-2). With 20/40 vision, the officers correctly identified all of the objects at 7 yards, but misidentified 14% at 15 yards. With 20/80 vision, officers misidentified 8% of the objects at 7 yards and 22% of the objects at 15 yards.

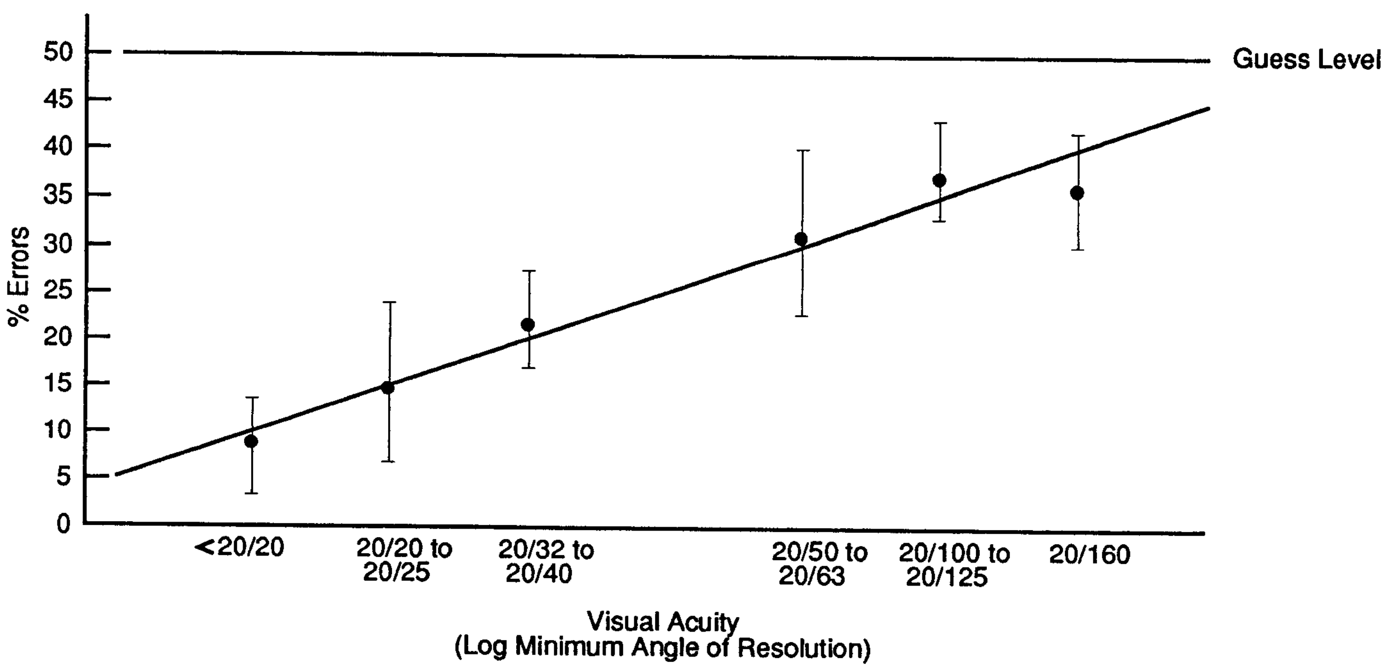
   Good and Augsburger (1987) decorrected 50 patrol officers from Columbus, Ohio who had 20/20 vision or better and then asked them to identify whether a life-size target 20 feet away was holding a firearm. To simulate night conditions (when most shootings in Columbus were found to occur) the trials were conducted under low-light conditions (10 cd/m^2), making them more challenging than those used by Giannoni. This resulted in a task that was moderately difficult, even without decorrection. The officers participating in this study misidentified 5-15% of the 60 targets presented without decorrection (Figure XI-1). With vision between 20/30 - 20/40, the error rate increased to 15-25%. At 20/50 - 20/60, the error rate increased to 25-40%.

TABLE XI-2
Percentage Correct Identifications for "Shoot" and "No Shoot" Scenario

Candidates	25 Yard Distance				15 Yard Distance				7 Yard Distance				Combined Distances			
	20/20	20/40	20/80	20/200	20/20	20/40	20/80	20/200	20/20	20/40	20/80	20/200	20/20	20/40	20/80	20/200
Cell B																
1	100	50.0	50.0	50.0	100	50.0	50.0	50.0	100	100	50.0	50.0	100	66.7	50.0	50.0
2	100	50.0	50.0	66.7	100	83.3	50.0	66.7	100	100	100.0	100.0	100	77.8	66.7	77.8
3	100	100.0	50.0	50.0	100	83.3	83.3	66.7	100	100	100.0	66.7	100	94.4	77.8	61.1
Cell A																
4	100	100.0	16.7	50.0	100	100.0	83.3	83.3	100	100	100.0	100.0	100	100.0	66.7	77.8
5	100	100.0	83.3	50.0	100	100.0	100.0	66.7	100	100	100.0	83.3	100	100.0	94.4	66.7
6	100	100.0	50.0	33.3	100	100.0	100.0	33.3	100	100	100.0	100.0	100	100.0	83.3	55.5
Average	100	83.3	50.0	50.0	100	86.1	77.8	61.1	100	100	91.7	83.3	100	89.8	73.2	64.8

From Giannoni, B. Entry-level vision requirements validation study. Personnel Bureau, California Highway Patrol. October 1981.

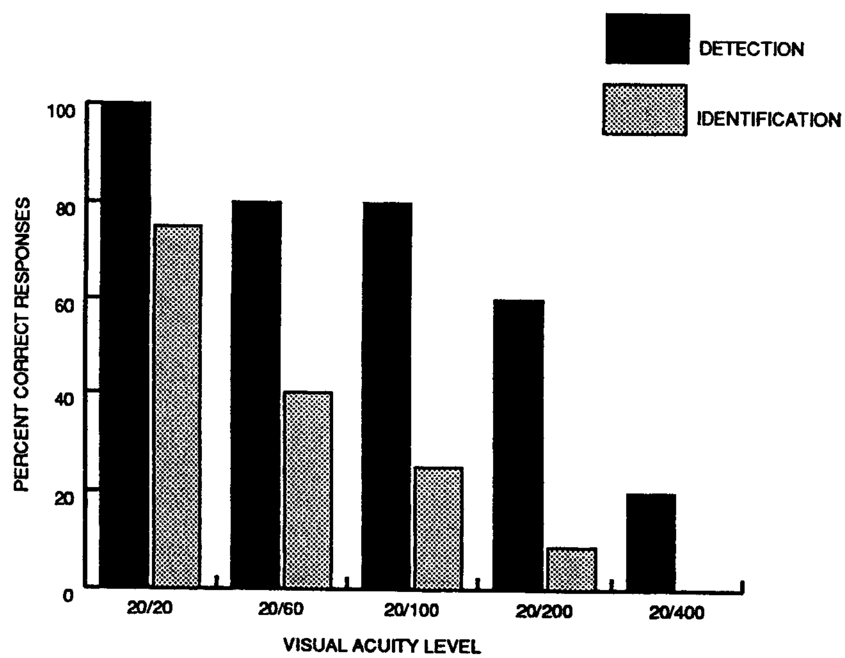
FIGURE XI-1
"Shoot-No-Shoot" Error Rates of Police Officers Tested at 20 Feet in Dim Light (N=60)



From Good, G.W. and Augsburger, A.R. 1987. Uncorrected visual acuity standards for police applicants. J Police Sci Admin. 15(1):18-23.

A third study involving weapon identification was conducted by Johnson and Brintz (1993) who decorrected six supervisors and counselors (with vision of 20/20 or better) from the California Youth Authority. The simulation was conducted under night lighting (5 to 7 cd/m^2) in an open dormitory setting. Fifteen surrogate wards were situated 5-7 feet away from the participants. In each trial, one ward was holding either a weapon (knife or screwdriver) or a non-weapon (toothbrush or comb). The participants were tasked with detecting which ward was holding an object, and identifying whether the object was a weapon or non-weapon. At 20/20 visual acuity, there was 100% correct detection of the ward holding the object (Figure XI-2). Detection fell to 80% correct for the 20/60 and 20/100 acuity levels, 60% at the 20/200 level, and 20% at the 20/400 level. The ability to identify objects declined more rapidly with reductions in visual acuity. Correct identification at the 20/20 level was 75%, which degraded to 40% at 20/60, 25% at 20/100, less than 10% at 20/200, and 0% at 10/400.

FIGURE XI-2
Average Correct Responses for Object Detection and Weapon Identification as a Function of Visual Acuity.



From Johnson, C.A. and Brintz, N. 1993. Entry Level Vision Standards for Group Supervisors and Youth Counselors (draft). Sacramento: California Dept. of Youth Authority.

2. Facial Recognition: The recognition of a face or facial expression from a distance is critically important to the safety of a patrol officer. When pursuing or trying to recognize a suspect in a crowded area, only the suspect's face may be visible. Recognizing and recalling facial features is also important when identifying a suspect in a line-up or when testifying in court.[3]

Sheedy (1980) performed a self-assessment to determine the acuity level required for face and feature detection. At night, he viewed an illuminated, familiar person from 20 feet while using decorrection lenses. Visual acuity of 20/30 enabled identification, while 20/40 visual acuity resulted in questionable identification. At 20/50, the subject's face became homogeneous and unidentifiable. The results of this study have been confirmed by Bullimore, et al. (1991), who investigated individuals with normal and reduced visual acuity. They observed a high correlation (r=.87) between letter chart acuity and the ability of individuals to correctly identify both individual faces and facial expressions associated with various emotional states (Table XI-3).

TABLE XI-3
Recognition of Faces and Facial Expressions as a Function of Visual Acuity

Visual Acuity	Distance at which 50% of faces and expressions can be identified in good illumination (100 cd/m^2)
20/20	14.0 yd.
20/30	8.3 yd.
20/40	5.9 yd.
20/50	4.4 yd.
20/80	2.5 yd.
20/200	0.7 yd.

From Bullimore, M.A., Bailey, I.L. and Wacker, R.T. 1991. Face recognition in age-related maculopathy. Invest Ophthalmol Vis Sci. 32:2020-2029.

[3]As with the other visual tasks discussed above, facial recognition at a distance or in poor illumination can be affected by numerous factors in addition to visual ability per se; for example, race (whites have difficulty identifying black faces; blacks recognize white and black faces equally well [Cross, et al., 1971]), age (less errors with subjects of same age [Mason, 1986], and gender (less errors with subjects of same gender [Ellis, et al., 1973]).

3. License Plate Identification: The ability to read and identify license plate numbers from a distance is another essential job function for patrol officers. For example, when in pursuit of a vehicle at 60 mph, maintenance of a safe distance (i.e., 6 car lengths) requires that the officer read the plate from a distance of 100 feet. Sheedy (1980) found that reading a license plate from this distance required 20/20 vision and good lighting conditions. By extrapolation, someone with 20/40 vision would be unable to read a license plate located more than 50 feet (3 car lengths) away (see Table XI-4). Sheedy noted that these distances assume no movement; under dynamic conditions, viewing distances would be even shorter.

SUMMARY: As Table XI-4 indicates, unimpaired visual acuity is required for many critical patrol officer duties that involve the quick identification of objects at varying distances. Therefore, **20/20 vision can be considered a justifiable qualification standard for patrol officers, assuming that their job duties include facial recognition, firing weapons at distant targets, or driving.** The need for unimpaired vision is even more compelling for officers who may be called upon to perform these duties at night. Johnson, et al. (1992) found that 20/20 vision is degraded to 20/60 under typical night lighting conditions (i.e., sodium vapor street lights); similarly, 20/60 vision is degraded to 20/200.

b. FAR ACUITY STANDARDS FOR EACH EYE VS. BOTH EYES

Although substantial evidence exists to support a stringent far acuity standard for patrol officers, separate issues must be addressed before deciding what standard should be applied to each eye separately vs. both eyes together. In order to justify an "each eye" standard, it must be shown that poor acuity in the weaker eye could have an adverse impact on the safe performance of patrol officer functions. Of relevance here is the likelihood that an officer's better eye would be temporarily unavailable or inoperative, such as in the following two situations:

Sighting around a barrier. Poor vision in one eye could force an officer to protrude his/her head beyond a barrier several centimeters further than would otherwise be necessary to make an observation. Theoretically, this could increase the risk of harm to the officer. However, each agency must evaluate how their officers actually peer around corners and other barriers to determine if this can be used as a basis for establishing a vision standard for each eye.

Trauma to one eye with sudden loss of vision. If there is a significant risk of an officer losing vision in one eye during a critical incident due to sudden trauma, a minimum far acuity requirement for both eyes would be justified. A recent review of LAPD worker's compensation records for the years 1987-1990 revealed that unilateral eye injuries during altercations occurred at an annual rate of approximately 1 per 300 officers assigned to field duty (Goldberg, 1993). Assuming that these injuries would completely impair vision in one eye, the risk of a functionally monocular LAPD officer losing the sight in his/her good eye during an altercation would be approximately 1/600 per year.

TABLE XI-4
Critical Task Performance vs. Far Acuity as Determined by Decorrection Studies.

VISUAL ACUITY	CRITICAL TASK PERFORMANCE
20/20	• In good light, can consistently identify weapons at distances of up to 25 yards[1] • In low light, will identify weapons correctly at 7 yards with an error rate of 5-15%[2] • Under night conditions, from 5-7 feet can detect whether an individual is holding an object with 100% accuracy and can identify object with 75% accuracy[3] • Facial identification with 50% accuracy at 14 yards[4] • License plate identification at 100 feet or 6 car lengths[5]
20/30	• "Reliable" facial identification at 7 yards; 50% accuracy at 8 yards[4]
20/40	• In good light, can consistently identify weapons at 7 yards, but error rate of 14% at 15 yards[1] • In low light, can identify weapons at 7 yards with an error rate of 25%[2] • Legal limit for driving any vehicle • License plate identification at 50 feet (3 car lengths)[5] • Facial identification is "questionable" at 7 yards; 50% accuracy at 6 yards[4]
20/50	• In low light, will misidentify weapons at 7 yards with an average error rate of >25%[2] • Cannot legally drive • Faces are "homogeneous" at 7 yards; 50% accuracy at 4.4 yards[4]
20/60	• Under night conditions, from 5-7 feet can detect whether an individual is holding an object with 80% accuracy and can identify object with 40% accuracy[3]
20/80	• In good light, can identify weapons at 7 yards with error rate of 8%; 22% error at 15 yards[1] • In low light, will misidentify weapons at 7 yards with an average error rate of >30%[2] • Facial identification possible with 50% accuracy only at 2.5 yards[4] • License plate identification at 25 feet[5]
20/100	• Under night conditions, from 5-7 feet, can detect whether an individual is holding an object with 80% accuracy and can identify object with 25% accuracy[3]
20/200	• In good light, can identify weapons at 7 yards with error rate of 17%; 39% error at 15 yards[1] • In low light, identifying weapons at 7 yards will be no better than guessing[2] • Under night conditions, from 5-7 feet, can detect whether an individual is holding an object with 60% accuracy and can identify object with less than 10% accuracy[3] • Facial identification is impossible beyond an arm's length[4] • License plate identification impossible at >10 feet[5] • Legal blindness as defined by the Social Security Administration and the IRS

[1]Giannoni, 1981
[2]Good & Augsbuger, 1987
[3]Johnson & Brintz, 1993
[4]Bullimore, et al., 1991
[5]Sheedy, 1980

The uncertainty and low likelihoods associated with these situations do not lend strong support for a far acuity requirement for the weaker eye based solely on concerns about temporary loss of vision in the stronger eye. However, a certain degree of vision in each eye is necessary for adequate peripheral vision (discussed in section 3), and especially for binocular fusion and stereopsis (discussed in section 4). Adoption of the guidelines discussed in these sections will serve to ensure adequate visual acuity in the weaker eye.

c. METHODS OF CORRECTION

Although good far acuity has been shown to be essential for the safe performance of a number of patrol officer duties, the uncorrected vision of a significant proportion of the population falls short of 20/20. Among a sample of 200 LAPD applicants, for example, 32% were found to have uncorrected vision of less than 20/20; even a far acuity standard of 20/30 would eliminate 19% of this sample (Table XI-5).

A variety of methods exist for correcting vision, including glasses, contact lenses, orthokeratology, and radial keratotomy. Each method has its attendant advantages and risks. This section discusses factors for an agency to consider when determining the acceptability of each method as a reasonable accommodation for visually impaired candidates.

TABLE XI-5
Distribution of Uncorrected Vision in 200 LAPD Applicants. Best Vision With Both Eyes Open.

Uncorrected Vision*	Percent of Applicants With This Level of Vision or Better
20/20	68%
20/25	75%
20/30	81%
20/40	83%
20/50	86%
20/80	90%
20/200	94%

*Single character errors were ignored except at the 20/200 level; 20/40-1 was considered 20/40, 20/200-1 was considered to be worse than 20/200.

From Goldberg, R.L. 1993. Uncorrected vision of LAPD applicants. Unpublished data.

1. Glasses:

Whether glasses represent a reasonable accommodation depends on the consequences of their use for the safety of the candidate and others. Two interrelated risks must be assessed: (1) the probability that an officer would lose the use of his/her glasses during a critical incident; and (2) the likelihood that the loss of glasses during a critical incident would result in significant impairment and/or injury. These concerns, in turn, must be balanced against the potential benefits of the use of glasses, such as protection against thrown objects, sand, etc.

a. **What is the probability of an officer losing the use of glasses while on duty, particularly during a critical incident?**

During a critical incident, glasses can become dislodged and/or broken when an officer is assaulted by a resisting suspect, when an officer is pursuing a suspect, or when an officer is required to make a sudden vehicle stop. Moreover, climatic factors such as rain or snow may also suddenly deprive an officer of full visual correction.

Since the probability of these events may vary greatly across agencies, each agency needs to examine its own experience. Methods used to accomplish this have generally consisted of questionnaire surveys of incumbents, or reviews of eyeglass reimbursement requests. Unfortunately, both methods have their limitations. Questions posed by a questionnaire may be easily misinterpreted if the respondents are not personally interviewed (Holden, 1993). Reimbursement lists do not include all incidents in which glasses are lost, rather only those instances in which they are broken.

There are several questionnaire surveys that are noteworthy, however. In 1987, the City of Los Angeles asked 195 incumbent LAPD officers who wore glasses whether they had ever been involved in critical incidents where they needed to see without their glasses (Mancuso, 1987). Eighty-six officers (44%) answered affirmatively (Table XI-6). When asked how often these situations occurred, approximately 28% of the officers stated less than once per year, 45% stated 1-6 times per year, 13% stated 7-20 times per year, and 14% stated more than 20 times per year. Together, these 86 officers had to function in at least 386 critical incidents per year without their glasses. For the entire group (N=195), on average, each officer was required to function without glasses approximately twice per year during a critical incident.

A very similar questionnaire survey was conducted on 292 officers from the City of Columbus, Ohio (Good & Augsburger, 1987). Fifty-two percent of the officers reported that their glasses dislodged while performing police duties at least once in their career (average length of service = 15.7 years). The probability of dislodgement was 34% per year per officer. In another study (Holden, 1993), 52% of police executives

TABLE XI-6
1987 LAPD Vision Questionnaire of Incumbent Police Officers

	Percent Answering Yes	
	Glasses	Contacts
Have you ever sustained an on-the-job injury specifically related to your wearing your corrective lenses?	5% (10/194)	0% (0/38)
Have you ever been involved in critical incidents, including but not limited to the apprehension of suspects, physical altercations, or vehicle pursuits, which necessitated that you see without your corrective lenses?	43% (83/195)	11% (4/38)
Has your wearing corrective lenses ever been an issue during a court appearance?	15% (27/184)	0% (0/36)
Do you believe that wearing corrective lenses presents an imminent hazard to your safety, that of your co-workers, or that of the public in any way?	6% (12/195)	0% (0/38)
Have you ever encountered any job safety problems caused by your corrective lenses?	28.9% (57/197)	2.6% (10/38)

Mancuso, R. 1987. Responses of myopic LAPD officers to a vision questionnaire. Unpublished study.

queried at an FBI conference reported that they knew of incidents in which officers lost their corrective lenses in the course of duty.

The Ohio survey also examined the impact of climatic factors. Sixty-seven percent of officers reported that they have had to remove their glasses because of rain or snow at least once in their career; 56% reported removing their glasses due to fogging. Unfortunately, the survey did not inquire as to whether the officers were involved in critical incidents during any of these occurrences.

There have been two published studies of glasses reimbursement rates. Sheedy (1980) reported that during a two-year period the City of Columbus, Ohio reimbursed 8 officers for glasses broken during altercations. Giannoni (1981) reported that during fiscal year 1979-80 the CHP reimbursed 17 officers for glasses broken during altercations and 2 officers who lost their glasses during foot pursuits (Table XI-7). Unfortunately, neither study provided data on the total number of glasses-wearing officers to permit calculation of the relative rates of loss or breakage.

Dodson (1993) and others have argued that the risk of an officer losing his/her glasses can be virtually eliminated by use of military spectacles and other devices aimed at securing glasses to the head. Several combat spectacles and glasses-retaining devices were evaluated by the POST

TABLE XI-7
Number of Prescription Eyeglass Reimbursement Requests Submitted by CHP During 1979-80 by Job-Related Loss or Breakage Categories

Category	Number of Reimbursement Requests
1. Assault/resisting arrest	17
2. CHP patrol car/motorcycle accident	4
3. Removing debris on highways/ freeways	1
4. Accident investigations	3
5. Rescue/first aid	4
6. Foot pursuits	2
7. Operating motorcycle	2
8. Routine stop	5
9. Other*	9

*Fall on pavement, sparks from battery, etc.

From Giannoni, B. Entry-level vision requirements validation study. Personnel Bureau, California Highway Patrol. October 1981.

vision panel.[4] Retaining devices such as straps and cords were found to be a potential safety hazard; during an altercation, they could be used to choke the officer. It was also determined that glasses held tightly by elastic, as is common with athletic eyewear, could be forcibly snapped back into the officer's face. Moreover, it was deemed unlikely that the tight elastic would be tolerated for an eight-hour shift.

Newer types of combat frames that are secured by a "D" shaped ear ring were also evaluated, but found to be uncomfortable when fitted tightly enough to avoid dislodgement during altercations -- a light tapping to the side of the frame caused severe pain to the bridge of the nose. Although more attractive than traditional military frames, the newer generation of combat spectacles were also found to be very conspicuous and relatively unattractive, which could have direct implications for their acceptance, use, and public reaction.

Note: All glasses worn by officers on duty should consist of polycarbonate lenses and frames that meet ANSI Z87.1 specifications. This will greatly reduce the likelihood and severity of injury to the officer.

[4] Vision panel participants are listed in footnote 1, p. XI-1.

b. How often would the loss of glasses result in injury or other negative consequences?

It has been argued that losing one's glasses during a critical incident would be unlikely to result in negative consequences for all but the severely myopic, since a suspect is usually situated very close to the officer in these situations (Holden, 1993; Dodson, 1993). Situations such as these may be further mitigated by the presence of a partner and/or the potential availability of a spare pair of glasses. However, a recent study conducted for the California Youth Authority showed that refractive error affects the visual detection and identification of weapons even at distances as short as 5-7 feet (Johnson & Brintz, 1993). Even those who advocate this position acknowledge the seriousness of the consequences that could (and do) occur in these situations. Holden (1993) reports an incident in which the loss of glasses is believed to have contributed to the death of an FBI agent. Dodson (1993) recommends that myopic officers be required to wear combat glasses and be provided with handguns that have special high-visibility sights.

A survey conducted in 1984 by POST asked 53 glasses-wearing officers from various agencies to report on any negative experiences (including but not limited to impairment or personal injury) associated with wearing glasses while on duty. As indicated in Table XI-8, only four negative consequences were reported, three of which were associated with glasses dislodgement during altercations. This rate is equivalent to an annual risk per officer of approximately 1.1% (average length of service = 5 years).

TABLE XI-8
Reported Instances of Negative Consequences Resulting From Use of Corrective Lenses by Officers

Outcome	Lenses	Impairment	Circumstances
Failure to provide required duty	Glasses	Chemicals	Maced in combative situations--arrest delayed
Physical harm	Soft contacts	Fogged up	Lack of sleep prevented me from safely operating motor vehicle
Property damage	Glasses	Dislodged	Glasses dislodged and slipped off in altercation
Property damage	Glasses	Dislodged	Glasses broken as result of fight
Physical harm	Glasses	Dislodged	Glasses flew off in fight with suspect on PCP. As result I received minor injuries while wrestling on pavement

From Briggs, R. 1984. Visual skills job analysis and automated vision testing. Unpublished technical report for the Commission on Peace Officer Standards and Training.

The POST survey also asked a larger group of officers whether they knew of other officers who experienced the same array of negative consequences on the job due to use of glasses. Such questions generate a large number of anecdotal cases, but not incident rates. One hundred and forty respondents reported a total of 16 such incidents (Table XI-9). Thirteen of these incidents involved altercations; one involved glasses becoming fogged during an arrest.

In assessing risks, an agency may wish to examine the following agency-specific factors:

<u>How often do officers patrol alone</u>? The 1984 POST survey reported numerous incidents in which officers who lost their glasses required the immediate assistance of other officers to control a suspect and make an arrest (see Tables XI-8 & XI-9). Holden (1993) reports an incident in which an officer who lost his glasses could not read the license number of an escaping suspect's vehicle.

<u>How often do foot pursuits occur after altercations</u>? In this situation, a distance is created between the officer and the suspect. An officer who has lost his/her glasses may subsequently misidentify the suspect in a crowd, overlook the suspect in hiding, or be unable to determine if the suspect is holding a weapon.

<u>How often does an officer discharge a gun after an altercation, and what are the distances involved</u>?

c. How often do glasses provide protection from hazards?

The 1984 POST survey also asked officers if glasses ever provided a beneficial effect. The 53 officers who wore glasses listed over 50 incidents in which they felt that glasses protected them from injury (Table XI-10). Some of these incidents involved confrontations with suspects who tried to disable the officer by throwing sand or other matter into the officer's face. Officers in the study who did not wear glasses also reported incidents in which they had observed the protective effect of glasses among their colleagues (Table XI-11).

An agency must balance the relative risks and benefits associated with wearing glasses when developing a standard on their use by officers. Since the degree of risk associated with wearing glasses is directly proportional to the candidate's degree of visual impairment (see Table XI-4), it is reasonable to conclude that glasses represent an acceptable accommodation for candidates with relatively mild degrees of visual impairment.

TABLE XI-9
Reported Instances of Negative Consequences Resulting from Corrective Lenses as Observed by Other Officers

Outcome	Lenses	Impairment	Circumstances
"Other"	Glasses	Fogged	Cold to warm -- glasses fogged. Had to clean glasses before continuing duty
"Other"	Glasses	Fogged	Had to clean & therefore, out of service
Damage to property	Glasses	Dislodged	Officer's glasses broken in physical confrontation
Physical harm	Glasses	Dislodged	415 fight -- officer struck in face -- momentary daze -- unable to see target until suspect struck again
Property damage	Glasses	Dislodged	Suspect knocked deputy's glasses to ground & broke them
Failure to provide service. Physical harm, property damage	Glasses	Dislodged	During arrest, partner lost his glasses, cut his nose and broke his glasses
Physical harm Auto accident	Glasses	Dislodged	Altercation with suspect/frame pushed in eyes, glasses in eye
Physical harm	Glasses	Dislodged	Cut on face from glasses being forced into the face
Other (altercation resulted)	Glasses	Dislodged	Suspect subdued by other officers
Failure to provide service	Glasses	Fogged	Entered sauna to investigate case -- glasses fogged & unable to see
Failure to provide service Auto accident	Glasses	Dislodged	Pursuit of suspect
Physical harm	Glasses	Dislodged	Deputy hit in face by suspect -- glasses (frame) cut his face and fell off
"Other"	Soft contact lenses	Dislodged	Contact dislodged during search of prisoner
"Other"	Glasses	Dislodged	Officer's glasses dislodged in altercation -- suspect ultimately injured
Failure to provide service	Glasses	Fogged	Other officers had to assist in arrest
Physical harm	Glasses	Dislodged	Officer struck while wrestling with suspect -- Officer cut on forehead
Failure to provide service. Damage to property	Glasses	Dislodged	Officer's glasses knocked off while attempting to make arrest

From Briggs, R. 1984. Visual skills job analysis and automated vision testing. Unpublished technical report for the Commission on Peace Officer Standards and Training.

TABLE XI-10
Reported Instances Where Corrective Lenses Provided Officers Protection

# Times	Lenses	Circumstances
1	Glasses	Broken windshield -- eyes protected from glass
5	Glasses	(1) Lead splatter at range (2) Wall particles -- removing evidence (3) Dura print fumes
4	Glasses	(1) Flying objects (2) Leaking chemicals in a fire
5	Glasses	Tear gas, objects thrown, struck in face, spit on
1	Glasses	Suspect threw sand -- glasses protected eyes
5	Glasses	Glasses protected eyes from thrown gravel
10	Glasses	Glasses acted as shield for eyes
10	Glasses	Prevented dust or hard objects from entering or harming my eyes
Many	Glasses	Objects thrown, i.e., dirt, sand, etc., by people and natural forces. Also limbs, branches, bushes scratched face but not eyes
-	Glasses	Strong winds -- debris hit glasses
Several	Glasses	Protection from wind blown dust/dirt
3	Glasses	Blowing sand in two storms. Blowback from weapon on range
4	Glasses	Protection against blowing sand/debris from helicopter blade thrust
Many	Glasses	Sand/rocks/bugs while a motorcycle officer

From Briggs, R. 1984. Visual skills job analysis and automated vision testing. Unpublished Technical Report for Commission on Peace Officer Standards and Training.

In deciding upon an uncorrected vision standard for glasses-wearers, an agency may also want to consider that visual correction is often not sought until one's native vision deteriorates into the 20/40 range. This would indicate that 20/40 can serve as a threshold level for establishing functional impairment. Visual acuity of 20/40 or better is also required by the California Department of Motor Vehicles.

TABLE XI-11
Reported Instances Where Other Officers' Corrective Lenses Provided Protection

# Times	Lenses	Circumstances
3	Glasses	Thrown bottles -- shattered glasses
2	Glasses	Suspect pursuit -- glasses broken in fight
-	Hard contacts	No injury when struck in face (would have been injured w/glasses)
2	Glasses	Prevented injury to eyes by shielding object
1	Glasses	Outside mirror shattered by bullet, throwing glass in deputy's face
1	Glasses	Eyes protected from chemical agent thrown by suspect
Several	Glasses	Thrown sand & gravel & other objects
2	Glasses	Motor officer being hit in glasses by small objects
1	Soft contacts	Eyes protected when refueling patrol car with propane
2	Soft contacts	Dust blown/thrown objects
1	Glasses	Windshield shattered -- glasses protected eyes from glass
1	Glasses	Protection on range
1	Glasses	Airborne particles hitting glasses
2	Glasses	(1) Exploding battery (2) Glasses struck & broken by foreign object
1	Glasses	Suspect threw sand at officer
3	Glasses	Flying rocks, dust, etc. bouncing off passing vehicle, etc.
Several	Glasses	Protection from sand/bugs/gravel for motor officers
2	Glasses	Motorcycle officers being hit in glasses by small objects

From Briggs, R. 1984. Visual skills job analysis and automated vision testing. Unpublished technical report for the Commission on Peace Officer Standards and Training.

The differences in responses of mildly vs. moderately myopic LAPD officers, although not statistically significant, lend further support for a 20/40 uncorrected standard (Mancuso, 1987). In response to the question: "Do you believe that wearing corrective lenses presents an imminent hazard to your safety, that of coworkers, or that of the public in any way?," 13% of the 23 officers who knew that their uncorrected vision in their better eye was worse than 20/40 answered affirmatively. This response compared to only 5% answering affirmatively among the other 172 less myopic officers.

SUMMARY: **An uncorrected standard of 20/40 for glasses-wearing officers is reasonable for agencies where the essential job functions include the use of single-officer patrol units, involvement in altercations with suspects, or use of lethal force.** A 20/40 standard also provides a margin of safety when working in low lighting conditions or inclement weather. At agencies where officers are rarely without support and are very unlikely to be subject to assault, a standard in the range of 20/50 to 20/100 is probably reasonable. Agencies who accept candidates with 20/200 vision or worse must do so with the awareness that the vision of these persons will be markedly impaired if they lose their glasses (Table XI-4).

The use of glasses (especially those with polycarbonate lenses and ANSI Z87.1 frames) is likely to reduce the overall incidence of unilateral eye injuries (see Tables XI-10 and XI-11). Moreover, sighting around a barrier is not an issue with glasses. Consequently, requiring an uncorrected minimum in the weaker eye of a person who wears glasses does not have strong support.

2. <u>Contact Lenses</u>:

Contact lenses can be classified by their rigidity. "Hard" lenses, made of polymethylmethacrylate (PMMA), are small, inflexible, and impermeable to oxygen. These were the original contact lenses developed decades ago. Advantages include easy care (no sterilization required) and the ability to correct astigmatic errors. Disadvantages include low comfort, easy dislodgement, high risk of particle entrapment and inappropriateness for overnight (extended) wear. Fully "soft" lenses were developed in the 1970's. These are large, flexible and permeable to oxygen. Advantages include high comfort, low risk of dislodgement, low risk of particle entrapment, and availability in extended wear varieties. Disadvantages include the need for regular cleaning/disinfection and the inability to correct for astigmatic error. The latter problem can be overcome with expensive soft lenses known as "Toric" which are somewhat thicker and weighted on one edge.

In the last decade, a new lens known as "semi-soft," "semi-rigid," "semi-permeable," or "gas-permeable" was developed. These are thinner hard lenses, made from materials permeable to oxygen. They are comfortable, can correct astigmatic error, and are associated with fewer complications than soft lenses (Key, 1990).

Two issues must be considered when determining whether contact lenses constitute a reasonable accommodation for visually impaired candidates: (1) safety, and (2) candidate compliance after hire.

a. **Safety**. Use of contact lenses could potentially create a safety hazard under certain circumstances:

(1) If both lenses were simultaneously lost during an altercation. Compared to glasses, this occurrence would be expected to be very rare. A phone survey was conducted on 12 optometrists in the Southern California area (Bible, 1993). The optometrists were selected randomly from a phone book, had an average of 2000 contact lens patients, and had been in practice for an average of 15 years. None of the optometrists could recall ever having a patient report losing both lenses simultaneously except during water sports. This result is not unexpected, since a direct blow to the eye may dislodge one lens, but would not affect the other.

While the loss of one lens would not affect vision in the other eye, this risk can be further reduced by prohibiting the use of hard lenses. Good & Augsburger (1987) asked 108 police officers who wore contacts if they had ever lost a contact lens while on duty; 18.8% of the 16 hard lens users answered affirmatively, compared to 10.5% of the 19 officers who used gas permeable lenses and 9.6% of the 73 officers who used soft lenses.

(2) Use of contacts in hazardous environments. During the 1960's and 1970's, recommendations were made to prohibit the use of contacts in hazardous environments due to concerns about absorption of chemicals and subsequent damage to the eye. However, these concerns were not based on controlled studies. Kok-van Aalphen (1985) and Royall (1977) found that candidates wearing soft contact lenses could actually tolerate tear gas for a slightly longer period of time. In fact, numerous published studies of both humans and animals exposed to a wide range of chemicals have found that contact lenses have either no effect or provide protection when the eye is exposed to toxins (Nilsson, et al., 1981; Nilsson & Andersson, 1982; Rengstorff & Black, 1974). Together, these studies have shown that absorption of some chemicals by soft lenses does occur, the lenses acting as a sponge to remove the chemicals from contact with the eye. There are no comparable studies on hard or semi-permeable lenses in toxic environments. However, since these smaller lenses do not completely cover the cornea, they would not be expected to provide the same protective benefit.

(3) Particle entrapment under a lens can result in a "contact lens attack" which is acutely painful and incapacitating. Vision in the non-affected eye is markedly impaired by sympathetic tearing and photophobia until the other lens is removed. Particle entrapment occurs when the lens slides over a particle or when tear fluid is exchanged from under the lens.

Although there are no published studies on the subject, many vision specialists agree that the risk of entrapment for hard and semi-permeable lenses is much greater than for soft lenses. Because they are smaller in diameter, hard and semi-permeable lenses slide on the cornea much more than do soft lenses. In addition, the rate of tear fluid exchange from underneath these lenses is an order of magnitude greater than with soft lenses. For these reasons, the American Optometric Association has recommended against the use of hard and semi-permeable lenses in industrial environments (AOA, 1990). Similarly, these lenses are not recommended for military aviation due to the high levels of particulate in cabin air (Polse, et al. 1990).

The safety of contact lenses has also been addressed in several questionnaire surveys of patrol officers:

- The 1984 POST vision study asked 17 officers if they ever experienced negative consequences from their personal use of contacts (12 wore soft and 5 wore hard lenses). Only one incident (which was non-critical) was described (Table XI-8). One hundred and forty officers were also asked if they had ever observed others experiencing negative consequences due to problems with their contacts. Again, only a single incident was reported (Table XI-9). However, the officers did report several incidents in which contact lenses provided protection against hazards (Table XI-11).

- In 1987, the City of Los Angeles conducted a questionnaire survey of 38 officers who wore contact lenses (soft and hard). No officer reported having sustained an on-the-job injury due to wearing contacts (Table XI-6). Similarly, none believed that their use of contacts created an imminent safety hazard. Only 4 (11%) reported having been involved in critical incidents where they had to see without their correction. Of these four, one officer reported that this occurs less than once per year, another reported occurrences of only 1-6 times per year, and the remaining two officers reported occurrences of more than 6 times per year. Ten of the officers indicated that they had encountered job safety problems caused by the contact lenses, due mostly to lenses slipping/popping out, or to particle/hair entrapment.

The available evidence suggests that soft contact lenses can be used by patrol officers with minimal risks. Their use is preferable to hard or semi-permeable lenses, since wearers are less likely to be subject to sudden incapacitation due to particle entrapment.

b. **Compliance.** Compared to lens dislodgement, there is an arguably greater likelihood that individuals will discontinue wearing their lenses, either temporarily or permanently.[5]

(1) Temporary Discontinuation: How many days per year will a patrol officer be unable to wear SCLs due to eye infections, corneal abrasions, allergies, or other medical conditions? Nilsson and Lindh (1984) reported that temporary medical conditions resulted in an average of only 3 days of non-wear per year for daily-wear SCL users. Studies of extended wear SCLs have found that complication rates are significantly higher than with daily wear lenses (Kirn, 1987); however, this appears to occur primarily in

[5]The following discussion is limited to soft contact lenses due to the considerations discussed earlier.

the first year of use. Several studies have found that those who successfully complete 12 months of use have temporary and permanent discontinuation rates which are similar to that of daily-wear users (Nilsson & Persson, 1986; Binder, 1983).

In persons who have worn SCLs successfully for more than a year, motivational factors are probably responsible for more episodes of temporary discontinuation than are medical complications. Since 1988, the LAPD has hired over 300 officers who have worn SCLs successfully for at least one year and have signed a pre-placement agreement obligating them to wear SCLs whenever assigned to field duty. (See Figure XI-3 for a sample pre-placement agreement.) During five random department-wide eye inspections conducted between June 1990 and November 1991, the LAPD found non-compliance rates to vary between 2-8%, with an average rate of 5%. Thirty officers were found on duty without their SCLs on a total of 39 occasions; five officers were non-compliant twice, and two officers were found non-compliant three times. Medical reasons were cited for non-compliance in only 6 (15%) of the incidents. More commonly, officers said they forgot their contacts, lost one, or now prefer to wear glasses. Examining non-compliance as a function of time since hire revealed a slight, nonsignificant increase in non-compliance in officers who had been on the job for longer periods of time (Figure XI-4). To date, discipline has been limited to written reprimands, and quarterly eye inspections have not been conducted regularly. Therefore, it is probable that non-compliance among these patrol officers could be significantly reduced by providing stronger administrative controls.

(2) Permanent Discontinuation: Several studies involving users of daily-wear SCLs have found that quit rates are highest during the first year of use. In a retrospective study of 196 SCL users, Robbins (1977) found that 13% quit within the first year after the lenses were prescribed. In a similar retrospective study of 92 new SCL users, Broome and Classe (1979) observed a first year drop-out rate of 28%; quit rates during the first and second 6 months of wear were both equal to about 15%. Both studies found that drop-out rates significantly decrease after the first year. Combined drop-out rates in the second and third year of use were 5-7% (Table XI-12).

As with temporary discontinuation, a large percentage of participants quit because of poor motivation. In the Broome study, only 5% of the participants quit daily-wear SCL use on the advice of a doctor (Figure XI-5). This has been a general finding in many studies. In a three-year prospective study of 100 SCL wearers, Nilsson and Lindh (1984) found that only 2% discontinued daily-wear SCL use on a permanent basis due to medical complications. After one year of successful use, similar findings have been reported for extended-wear SCL users (Nilsson & Persson, 1986; Binder, 1983). To date, only one of the 300 LAPD officers has permanently discontinued SCL use due to medical complications.

SUMMARY: Based on these studies of safety and compliance, it would appear that **the use of soft contact lenses can be considered a reasonable accommodation for candidates who have been successful SCL wearers for at least one year.** However, before SCL candidates are granted waivers of uncorrected vision requirements, **an agency should develop a program to ensure that these individuals will not go into the field without wearing their contact lenses.**

With proper administrative controls in place, the likelihood of either noncompliance or SCL dislodgement (particularly double dislodgement) is quite low. Some agencies, nevertheless, may feel that the severity of the risk posed if an extremely myopic officer needed to perform without visual correction offsets even this low likelihood, and as a result provides ample justification for establishing an uncorrected vision standard. However, **if an uncorrected standard is established, it is recommended that it be no more stringent than 20/200.** Vision at this level, although severely limited[6] (see Table XI-4), would be expected to allow some basic functional capacity as a patrol officer (under good lighting conditions). It must be noted, however, that upwards of 6% of the applicant population may be unable to meet even a 20/200 uncorrected standard (see Table XI-5).

TABLE XI-12
Rates of Soft Contact Lenses "Drop-Out"

Time Period	Number Using SCLs at Beginning of Time Period	Percent Who Quit During Time Period (n)
0-12 Months	288	18% (51)
13-24 Months	136	5% (7)
25-36 Months	74	7% (5)

Combined data from: Broome, P.W. & Classe, J.G. 1979. Long-term success in contact lens wear. Contact Lens Forum (September):15-27; and Robbins, J.C. 1977. A three-year retrospective soft lens contact lens study. In Proc 2nd Natl Res Symp Soft Contact Lenses Int. Congr. Ser. No. 398:57-61. Excerpta Medica. Amsterdam.

[6]20/200 is the threshold for functional blindness as established by the Social Security Administration.

FIGURE XI-3
Sample Pre-Placement Agreement Involving Use of Soft Contact Lenses

SAMPLE

PRE-EMPLOYMENT NOTICE OF REASONABLE ACCOMMODATION REQUIREMENTS

Name: ______________________________ Date of Hire: ______________

Medical Condition: Poor uncorrected distance vision - myopia correctable with soft contact lenses.

I acknowledge that the medical condition noted above was present at the time that the (name of law enforcement agency) offered me employment. I affirm that I am currently, and have been for the past twelve months prior to employment, a bona fide, successful soft contact lens wearer. I also understand that my use of soft contact lenses is permitted as a reasonable accommodation for my distance vision myopia.

I understand that my ability to perform the duties assigned to me as a full-duty patrol officer may be contingent upon my ability to successfully wear soft contact lenses on duty, and I shall wear such lenses whenever I am on duty except when authorized by my supervisor (or the Employee Assistance Unit) to do otherwise. I also understand that it is my responsibility to notify my supervisor (or the Employee Assistance Unit) should I become unable to wear soft contact lenses while on full duty or should I take any other medical action which would otherwise affect my vision or my ability to wear soft contact lenses. I am aware that if I become unable to wear soft contact lenses while on full duty, I may be assigned to restricted duty assignments.

I have been informed that, as part of the reasonable accommodation to the medical condition noted above, my use of soft contact lenses may be candidate to verification by my employer and to such medical eye examination as necessary in the judgement of my employer's medical staff during the last month of my training at the Police Academy and thereafter, unless otherwise medically indicated.

By my signature below, I acknowledge that I have read and accept the conditions of this Notice.

______________________________ ______________________
SIGNATURE DATE

FIGURE XI-4
Non-Compliance of LAPD Officers with Soft Contact Lenses Based on Time Since Hire (N=808)

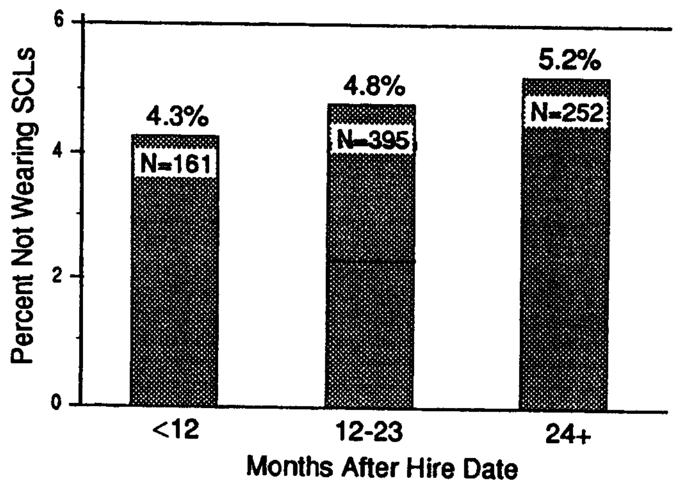
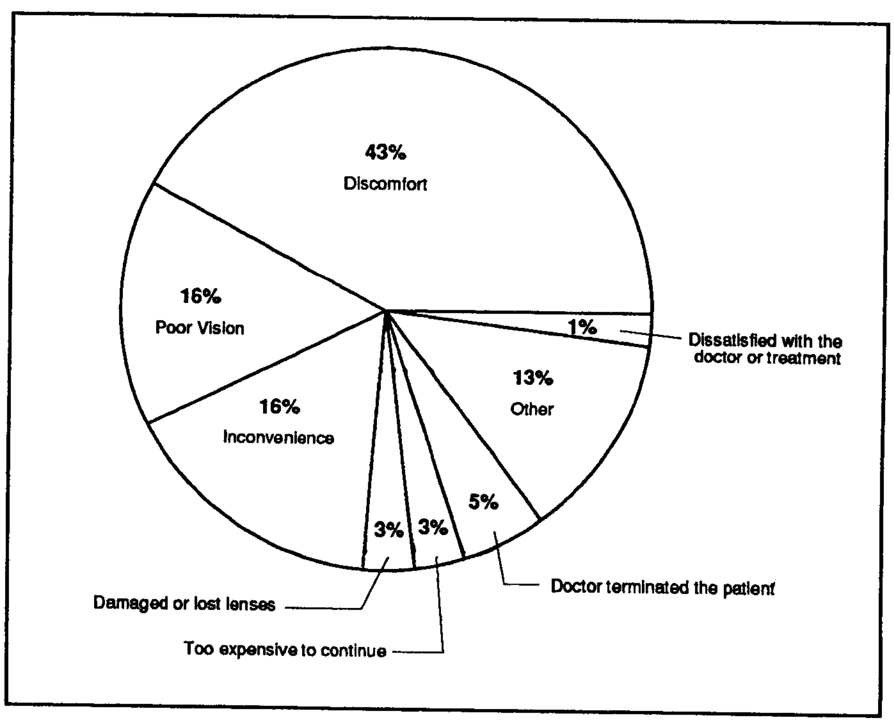


FIGURE XI-5
Reasons for Discontinuing Contact Lens Wear (N=92)



Adapted from Broome, P.W. and Classe, J.G. 1979. Long-term success in contact lens wear. Contact Lens Forum (September): 15-27.

3. Orthokeratology:

Orthokeratology refers to the use of special hard contact lenses that "mold" the shape of the cornea to reduce myopia. The method is somewhat analogous to the use of orthodontics for realigning teeth. The individual may wear the lenses for a period of time, then remove them to enjoy a period of good vision without lenses. The lenses are put back into the eyes 1-3 days later when the individual's vision deteriorates. Some persons wear gas-permeable ortho-K lenses only while sleeping, and then sustain good vision without contacts the next day.

There are several concerns regarding the use of orthokeratology by patrol officers:

(a) Fluctuating vision: When the lenses are not worn, the wearer's vision slowly deteriorates. The individual reinserts the lenses when the poor vision is no longer tolerable. Since many find vision even in the 20/40 - 20/50 range tolerable, it is not unlikely that an officer would be on duty with vision in this range. It is unrealistic to expect an agency to perform vision testing at the beginning of each shift and at sufficiently frequent intervals thereafter to ensure vision (with or without the lenses) at or near 20/20.

(b) Compliance: Fluctuating vision could be eliminated by requiring the candidate to wear the lenses while on duty. However, it must be noted that orthokeratology lenses are frequently worn only while sleeping. (In fact, many orthokeratology users spend $1,500-$2,000 because they do not want to wear contact lenses all of the time.) Furthermore, since they do not comply with the cornea's natural contour, some individuals find these lenses quite uncomfortable.

(c) Particle entrapment: Since orthokeratology lenses are either hard or semi-permeable, requiring constant use by an officer could create a similar risk of particle entrapment (see "Contact Lenses").

The unique advantage of orthokeratology is that visual acuity is maintained when the lenses are removed/dislodged. However, this benefit would require constant use while on duty, a practice that is contrary to the way these lenses are commonly used as well as unrealistic for those individuals who find the lenses uncomfortable. Moreover, these lenses create the same risk of sudden incapacitation due to particle entrapment as do hard or rigid gas permeable lenses.

Because of concerns over fluctuating vision, monitoring compliance, and particle entrapment, **the use of SCLs is preferred over ortho-k lenses for patrol officers.** Therefore, candidates should be encouraged to switch from orthokeratology lenses to soft contact lenses. At a minimum, before ortho-k wearers are accepted, they need to show **a history of problem-free, daily, daytime use of these lenses for a period of no less than one year;**

furthermore, **strict administrative controls (including frequent lens checks) should be implemented to ensure that ortho-k wearers do not perform on duty without their lenses.**

d. FAR ACUITY SUMMARY

Based on available evidence, the following recommendations are made for establishing far acuity standards for entry level patrol officers:

Corrected Vision:

- Best corrected vision of 20/20.
- Best corrected vision should be assessed for both eyes together.

Use of Glasses: Due to the likelihood of dislodgement or breakage, candidates who wear glasses should meet an uncorrected far acuity standard of between 20/40 - 20/100. The exact far acuity standard selected should be based on agency-specific considerations such as:

- The likelihood and circumstances surrounding the use of firearms at that agency (e.g., distances of targets, frequency of foot pursuits in conjunction with weapon use)
- The likelihood of engaging in combative situations
- Deployment of one officer patrol units
- Inclement weather, night shift duty, and other environmental conditions that may affect visibility with glasses

Use of Contact Lenses:

- Use of soft contact lenses (SCLs) is permissible by candidates who have at least one year of successful SCL use, and provided that the agency uses pre-placement agreements and has a monitoring program in place.
- SCL use is preferred over the use of other types of contact lenses (i.e., rigid gas permeable or hard lenses) due to concerns of particle entrapment and dislodgement.
- The establishment of an uncorrected vision standard for SCL wearers should be an agency-specific risk management decision. However, should an agency decide to create an uncorrected standard, it is recommended that it be no more stringent than 20/200 (both eyes).

Use of Orthokeratology:

- Because of concerns over fluctuating vision, particle entrapment, and the inability to monitor compliance, SCLs are preferred over ortho-k lenses for patrol officers. At a minimum, ortho-k wearers should be required to always wear their lenses while on duty, and to meet the same visual acuity and compliance requirements as discussed above for SCL wearers.

e. RECOMMENDED EVALUATION PROTOCOL

Prior to evaluating candidates, the hiring agency should supply the vision specialist with a set of written guidelines which describe the accepted policies on corrected vision, uncorrected vision, contact lenses, and orthokeratology.

Procedures for testing far acuity are described under General Screening Recommendations.

CORRECTED VISION: The physician should seek an explanation if a candidate's corrected vision (or native vision if no corrective devices are used) is worse than 20/20 in each eye, regardless of the agency's corrected vision standard. While the most common cause is inadequate corrective lens prescription, poor corrected vision may be indicative of serious eye disease which should be evaluated by a vision specialist. This possibility should be ruled out before a candidate is given a clearance.

UNCORRECTED VISION: In most cases, candidates who do not meet the uncorrected vision standard should have an opportunity to have their vision retested by their personal vision specialists. Unfortunately, measurement of uncorrected vision can vary with squinting, time of day, and the lighting conditions during testing. Consequently, physicians are commonly faced with the task of resolving discrepancies between the results of pre-employment vision testing and the results reported by a private specialist. To adequately resolve these discrepancies, the physician must understand a few basic concepts regarding the optics of corrective lenses:

Lenses with a spherical shape are used to correct either nearsightedness (myopia) or farsightedness (hyperopia). The "strength" or curvature of the required lenses is measured in units known as diopters (D). The diopter strength of a lens is always preceded by either a minus (-) or a plus sign (+) to denote concavity or convexity, respectively. Minus (-) lenses correct for myopia; plus (+) spherical lenses correct for hyperopia.

Astigmatism is an optical irregularity along an axis. Cylindrical lenses aligned along the same axis can correct this error. By convention, cylindrical correction is usually expressed as "minus" (-) diopters, followed by the axis of the cylinder expressed in degrees.

Eyeglass prescriptions are based on the subjective measurement of the individual's spherical and cylindrical refraction. When this is performed manually, it is known as the manifest refraction (MR). Refraction can also be conducted by an automated process, but it is not as accurate. The refraction is always expressed as the spherical correction followed by the cylindrical correction. For example, -1.50 -1.00 x 90 indicates that lenses must be made with a minus 1.5 diopter sphere combined with a 1.0 diopter cylinder aligned along an axis of 90 degrees. If someone has no astigmatism, the cylinder correction is omitted. If someone has only astigmatism, the spherical correction is designated as "plano" (for example, plano -4.50 x 135).

Knowing a candidate's MR can be very helpful in determining the likelihood that squinting occurred during private testing. Peter's Table (Table XI-13) can be used to predict the most probable distant acuity based on refraction. To use Table XI-13, first find the candidate's spherical correction along the far left side of the table. If there is no astigmatism, the predicted acuity is found in the first column to the right (minus cylinders = 00). For example, if the MR is [-1.25], distant acuity is most likely 20/70.

Note that predicted acuity in hyperopes decreases with age. For example, an MR of [+3.00] would indicate an acuity of 20/25 in a 15-year-old, but 20/200 in a 50-year-old. This age-related effect is due to the gradual loss of accommodative power of the crystalline lens in the eye. In young persons, accommodation can completely compensate for mild hyperopia.

Cylindrical correction is found along the top of the table. For the purpose of estimating acuity, the axis of the cylinder can be ignored. Examples include: [plano -2.00 x 125] = 20/70; [+1.75 -1.25 x 275] in a 28 year-old = 20/30; [-0.25 -0.75 x 50] = 20/40.

Note that a small amount of astigmatism can actually improve the vision of older hyperopes. For example, a 45-year-old with an MR of [+3.00 - 2.00 x 45] is likely to have 20/80 vision, while a similar hyperopic 45-year-old without astigmatism (MR of [+3.00]) would probably have 20/200 vision.

Astigmatisms must be expressed as "minus" cylinder when using Peter's Table. If the MR is written with "plus" cylinder, this can be converted to minus by adding the number of cylindrical diopters to the spherical correction (axial changes can be ignored). For example, an MR of [+1.00 +1.00] is equivalent to [+2.00 -1.00]; [-1.00 +1.00] = [plano -1.00]; [-.25 +3.75] = [+3.50 -3.75].

The following is presented as a suggested algorithm for evaluating candidates whose uncorrected distant acuity, as measured during the screening examination, is beyond the hiring agency's standards. Repeat testing by the agency's vision specialist should be performed on all such candidates (preferably with a different eye chart). The most favorable test results should be evaluated using the following guidelines.

GROUP I: UNCORRECTED ACUITY IS WORSE THAN THE AGENCY STANDARD BY ONLY ONE LINE

A "line" refers to the lines on a vision chart (e.g., the 20/40 line). These candidates should have the opportunity to submit the results of a current, private examination which includes the MR. The examination technique used should be the same as described in "General Screening Recommendations - Routine Testing." Past records of previous eye exams should be requested, since they may reveal the candidate's true vision when not motivated to squint.

- If past records and the current private exam indicate acceptable vision, the candidate is passed.
- If either the current private exam results <u>or</u> past records confirm unacceptable vision, the candidate should be restricted from performing vision-oriented essential job functions (e.g., driving, weapon use, etc.) Past records, unlike the results of a current private exam, are unlikely to be biased by squinting.[7]
- If the current private exam is acceptable, but no past records are available, use the MR and Peter's Table (Table XI-13) to assess the likelihood of squinting.

GROUP II: UNCORRECTED ACUITY IS WORSE THAN THE AGENCY STANDARD BY TWO LINES OR MORE

Repeat testing by a private vision specialist is usually not helpful. These candidates should be restricted from involvement in critical situations which may result in loss of glasses. The use of soft contact lenses is generally an acceptable alternative for these candidates, except for those individuals who fail to meet an agency's uncorrected acuity standard for soft contact lens wearers (if any).

<u>SOFT CONTACT LENSES</u>: The physician should determine if the candidate has worn SCLs regularly and successfully for at least one year. To evaluate the candidates' past experiences with SCL use, and the existence of any contraindications to the continued successful use of SCLs, candidates should be asked to submit the results of a current contact lens examination by a vision specialist (see form provided as Figure XI-6), and a copy of their vision records.

There are several absolute and relative contraindications to the use of contact lenses. Diabetes can result in loss of corneal sensation which can decrease an individual's awareness of epithelial damage from the lens. Increased glucose concentrations in the tear fluid also serve to encourage infections. Other absolute contraindications include autoimmune disorders, which are commonly

[7]Note: Vision does not improve with age.

complicated by the sicca syndrome (dry eyes and mouth). These would include scleroderma, Sjorgen's syndrome, rosacea, rheumatoid arthritis, and lupus.

Relative contraindications to SCL use include a history of dry eyes, use of antihistamines (which decrease tear flow), or a history of medical complications from contact lens use. These include corneal abrasion, corneal infection, neovascularization of the cornea (often seen in post-radial keratotomy patients who wear contacts), and giant papillary conjunctivitis (GPC). GPC is a sterile inflammatory reaction of the upper eye lid caused by friction and irritation from repetitive blinking over the upper portion of the contact lens. This condition occurs more commonly with extended wear lenses. It is treated with steroids and discontinuation of contact lens use for a period of time.

Candidates who currently wear hard or semi-permeable lenses should be encouraged to be refitted with soft lenses. Those with astigmatism may have to purchase "toric" lenses at an increased cost. Complications such as neovascularization, superior limbic keratoconjunctivitis, GPC, corneal ulcers, and infections are more common with soft lenses (Key, 1990). For this reason, requiring some minimal period of use of SCLs, such as 6 months, would not be unreasonable for candidates who have an established history of success with hard or semi-permeable lenses and no prior negative experience with SCLs.

<u>USE OF SCL AFTER RADIAL KERATOTOMY (RK)</u>: It is not uncommon for individuals to obtain SCLs when their post-surgical vision requires correction. Unfortunately, there is evidence that SCLs (especially extended-wear) can increase the risk of neovascularization of the surgical scars (Edwards & Schaefer, 1987). In the largest post-RK study, all participants who developed significant amounts of neovascularization 1-5 years after surgery had worn SCLs (Waring, et al., 1991). SCLs may also worsen a common complication of RK known as progressive hyperopia (Edwards & Schaefer, 1987). For these reasons, RK surgery should be considered a relative contraindication to the use of SCLs. In post-RK candidates with unacceptable uncorrected far acuity, the use of SCLs should not be considered a reasonable accommodation unless there is no evidence of significant neovascularization (i.e., vascularization of one or more scars for at least 25% of its length [Waring, et al., 1991]) or progressive hyperopia. Moreover, these candidates should be evaluated for diurnal variation as in any other post-RK candidate (see Section 2 - Radial Keratotomy).

<u>ORTHOKERATOLOGY</u>: Measuring "uncorrected acuity" in these candidates is difficult because their vision slowly deteriorates after their ortho-k lenses have been removed. For this reason, vision records which pre-date the initiation of ortho-k must be obtained to establish the candidates' "native" uncorrected vision. Candidates whose uncorrected vision does not meet the agency's standard should be encouraged to obtain SCLs. At a minimum, ortho-k wearers should be required to always wear their lenses while on duty and to meet the other criteria stipulated for SCL wearers.

TABLE XI-13
Peter's Relation of Error and Acuity

	minus cylinders																
Sphere	00	.25	.50	.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00
-2.00	200	200	200	200	or poorer												
-1.75	100	100	100	200	or poorer												
-1.50	80-100	80-100	100	100	100	200											
-1.25	70	70	70	80	80	100	100	100	200								
-1.00	60	60	70	70	80	80-100	100	100	100	100-200	200						
-0.75	50	60	60-70	70	70-80	80	80	80-100	200								
-0.50	30-40	40	50	50	60	60-70	70	80	80	100	100	100	100	200			
-0.25	25	25-30	30-40	40	50	60	60-70	70	80	80	100	100	100	100	100-200	200	
00	20	20-25	25-30	30-40	40-50	50	60	70	70	80	80	80-100	100	100	100	200	
+0.25	20	20	25	25-30	30-40	40-50	50-60	60	70	70	80	80	100	100	100	100	100-200
+0.50	20	20	20	25	30	40	50	50-60	60	60-70	70	80	80	100	100	100	100
+0.75	20	20	20	25	25-30	30-40	40-50	50	60	60-70	70	70-80	80	80	100	100	100
+1.00	20	20	20	25	25	30	40	50	50-60	60	70	70	80	80	80-100	100	100
+1.25a	20	20	20	25	25-30	30	40	50	50-60	60	70	70	80	80	80-100	100	100
b	20	20	20	25	25-30	30	40	50	50-60	60	70	70	80	80	80-100	100	100
c	25	25	25	25-30	30	40	40-50	50	60	60-70	70	70-80	80	80	100	100	100
+1.50a	20	20	20	25	25	30	40	50	50	60	70	70	70	80	80	80-100	100
b	20	20	25	25	25-30	30	40	40-50	50	60	60-70	70	70-80	80	80	100	100
c	30	25-30	25-30	30	30-40	40	50	50	60	60-70	70	70-80	80	80	100	100	100
+1.75a	20	20	20	25	25	30	40	40	50	50	60	60	70	70-80	80	100	100
b	25	25	25	25	25-30	30	40	40-50	50	60	60	70	70	80	80	100	100
c	40	30-40	30	30-40	40	40-50	50	50-60	60	60-70	70	70-80	80	80	100	100	100
+2.00a	20	25	25	25	25	30	30-40	40	50	50-60	60	70	70	70	80	80	100
b	25	25	25	25	30		40	40-50	50	60	60	70	70	80	80	100	100
c	50-60	40-50	40	40	40-50	50	50-60	60	60-70	70	70	80	80	80-100	100	100	100
+2.25a	25	25	25	25	25	30	40	40	50	60	60	60-70	70	70	80	80	100
b	25	25	25	25-30	30	30-40	40	40-50	50	60	60	70	70	80	80	100	100
c	60-70	60	50	50	50-60	60	60-70	70	70	70-80	80	80	100	100	100	100	100-200
+2.50a	25	25-30	25	25	25-30	30	30-40	40	50	50-60	60	60-70	70	70	80	80	100
b	30	30	25	30	30	40	40	50	50	60	60	70	70	80	80	100	100
c	70-80	70	60	60	60	60	60-70	70	70	70-80	80	80	80-100	100	100	200	200
+2.75a	25	25	25	25	30	30	30-40	40	50	50-60	60	60-70	70	70	80	80	100
b	30	30	30	30	30-40	40	40-50	50	50-60	60	60-70	70	70	80	80	100	100
c	100	80	70-80	60-70	70	70	70	70-80	80	80	80	80-100	100	100	100	200	200
+3.00a	25	25	25	25	30	30	30-40	40	50	50-60	60	70	70	70	80	80	100
b	40	30-40	30	30-40	40	40	50	50	60	60	70	70	70-80	80	80	100	100
c	200	100	80	70-80	70-80	80	80	80	80	80-100	100	100	100	100	200	200	200
+3.25a	30	30	25	30	30	40	40	50	50	60	70	70	70	70-80	80	80-100	100
b	40-50	40	40	40	40	40-50	50	50-60	60	60-70	70	70	80	80	80-100	100	100-200
c	200	200	100	80	80	80	80-100	100	100	100	100	100-200	200	200	200	200	200
+3.50a	30	30	30	30	30	30	40	40-50	50	60	60-70	70	70	80	80	100	100
b	50	50	40-50	40	50	50	50-60	60	60	70	70	70-80	80	80-100	100	100	200
c	200	200	200	100	100	100	100	100	100	100-200	200	200	200	200	200	200	200
+3.75a	40	30-40	30	30	30	30	40	50	50-60	60	70	70	70-80	80	80-100	100	100
b	60	50-60	50	50	50	50-60	60	60	70	70	70-80	80	80	100	100	100-200	200
+4.00a	40-50	40	30	30	30	30-40	40-50	50	60	60-70	70	70-80	80	80-100	100	100	100-200
b	70	60	50-60	50	50-60	60	60	70	70	70-80	80	80	100	100	100-200	200	200
+4.25a	50	40-50	40	30	30	40	50	50-60	60	70	70-80	80	80	100	100	100-200	200
b	70-80	70	60	60	50-60	60	60-70	70	70	70-80	80	80	100	100	100-200	200	200
+4.50a	60	50	40	30	30-40	40-50	50	60	60-70	70	80	80	100	100	100-200	200	200
b	80-100	70-80	60-70	60	70	70	70	80	80	80	100	100	100-200	200	200	200	200
+4.75a	70	50-60	40-50	40	40	50	50-60	60-70	70	70-80	80	80-100	100	100	200	200	200
b	100-200	80-100	70-80	70	70	70-80	80	80	80-100	100	100	100-200	200	200	200	200	200
+5.00a	70	60-70	50	40	40-50	50-60	60	70	70-80	80	80-100	100	100	200	200	200	200
b	200	100	80	70-80	80	80	80-100	100	100	100-200	200	200	200	200	200	200	200

Composite chart of refractive state to V.A. Derived from Peter's multiple tables. All figures are the denominator of the Snellen Fraction, whose numerator is 20/. Where given, a indicates age group from 5 to 15; b indicates age group from 25 to 35; c indicates age group from 45 to 55. Where not indicated, data applies to all ages. Above +3.50 sphere, acuity for c group poorer than 20/200 for all errors.

From Borish, Irvin M. Visual Acuity. Clinical Refraction, 3rd ed. 1970. Butterworth-Heinemann. Stoneham, Mass.

FIGURE XI-6
Sample Soft Contact Lens Examination Form

SAMPLE

SOFT CONTACT LENS (SCL) DATA SHEET FOR PEACE OFFICER CANDIDATES

TO QUALIFY FOR THE JOB OF PATROL OFFICER, YOU MAY BE REQUIRED TO WEAR SCLs. WE DO NOT ACCEPT USE OF HARD OR "SEMI-RIGID" LENSES DUE TO GREATER RISK OF HAVING THE LENS POP OUT OF THE EYE. PLEASE SUBMIT A CURRENT EYE EXAMINATION (WITHIN THE LAST THREE (3) MONTHS) FROM YOUR PRIVATE OPTOMETRIST OR OPHTHALMOLOGIST THAT INCLUDES ALL OF THE FOLLOWING INFORMATION:

a. When did patient begin using SCLs: ____________________

b. Date last pair of lenses dispensed: ____________________

c. Condition of current lenses: ____________________

d. Is there a history of any difficulties with SCL use?: ____________________

e. Date of last full examination of eyes: ____________________

f. Uncorrected distant visual acuity: OD=20/ ______ and OS=20/ ______

g. Corrected distant visual acuity with current contacts: OD=20/ ______ OS=20/ ______

h. Refractive error: OD= ____________; OS= ____________

i. Please list all prescription and OTC medications: ____________________

j. Does the patient have any of the following conditions:

______ Dry Eyes ______ Rosacea
______ Scleroderma ______ Rheumatoid Arthritis
______ Sjorgen's Syndrome ______ Lupus
______ Diabetes ______ Epilepsy

k. Statement of any medical contraindication to continued wearing of SCLs.

____

l. Doctor's Name: ____________________

Doctor's Signature: ____________________

Office Address: ____________ Phone Number: ____________

2) RADIAL KERATOTOMY

a. GENERAL CONSIDERATIONS

Refractive surgery to correct myopia has been used as an alternative to lenses. Radial keratotomy (RK) is the most common technique; it involves cutting a set of 4-8 spoke-like shallow incisions on the cornea, beginning just outside the pupil and running out toward the limbus. The incisions weaken the sides of the cornea and make the central portion flatter.

Several long-term follow-up studies of this procedure have shown that most who have undergone this procedure are able to see adequately without correction. The largest study is the ongoing Prospective Evaluation of Radial Keratotomy (PERK) which has followed about 400 individuals for five years. At five years after surgery, 65% of PERK participants reported not needing to wear glasses (Waring, et al., 1991).

The acceptability of RK for patrol officer candidates depends on the following four considerations:

1) Post-RK impairment of visual function: About 3% of individuals experience a loss of two or more lines of best spectacle-corrected visual acuity (Waring, et al., 1991). However, candidates with unacceptable corrected vision can be readily identified during routine vision testing.

   Of greater concern are problems that are difficult to detect with routine testing, such as glare disability and impaired vision under dim conditions (Atkin, et al., 1986). The prevalence and severity of these problems is unknown. In addition, many individuals report the presence of "starbursts" - radiating lines around focal light sources such as headlights or street lights. This is thought to be due to the scattering of light from the portion of the radial scars that extend over the dilated pupil (Waring, et al., 1991). Most individuals report that this does not interfere with their normal activities, but some have stated that it severely disrupts their night driving ability.

   Candidates who have had RK should be carefully questioned regarding glare, starbursts, and difficulty with night vision. Specific tests of glare disability and contrast sensitivity exist, but are not as readily available nor as well stan-dardized as those for far acuity. However, the optometric or ophthalmology department of any major university should be able to assist in locating a site where these tests are conducted.

2) Stability of the uncorrected vision within 2-3 years: Deterioration back to unacceptable levels within 2-3 years can occur due to either loss of surgical correction (increasing myopia) or surgical overcorrection (progressive hyperopia).

Significant loss of surgical correction ultimately occurs in about 25% of RK patients (Waring, et al., 1990). However, in 85% of these cases, the failure of the procedure is evident within the first six months after surgery (Waring, et al., 1990). After six months, the probability of developing -1.00 D or more of myopic error is only 4% within the next 3.5 years (Waring, et al., 1990).

In contrast, surgical overcorrection does not usually begin to develop until 6-12 months after the procedure. Between 6-12 months, 22% of patients will have an MR change of +0.50 D or more (Waring, et al., 1985). From 1-4 years post-op, 15-31% of patients will experience a change of +1.00 D or greater (Waring, et al., 1990; Deitz, et al., 1986). It is not known whether progressive hyperopia ever ceases. For this reason, the PERK study was extended to 10 years.

Whether this progressive hyperopia will become clinically significant in the near future depends on the age of the candidate and how rapidly the hyperopia is developing. As illustrated in Table XI-13, the optic lens of younger persons can compensate for a large amount of hyperopia by increased accommodation. Consequently, it is very unlikely that persons under the age of 35 will have their far acuity impaired by progressive hyperopia. However, in older candidates, observation of the rate of progression can be used to estimate when the candidate would be expected to exceed a given uncorrected far acuity threshold. The accuracy of these estimates is questionable, however, since there is approximately a five line variation in far visual acuity for a given refraction in post-RK patients (Rice, et al., 1985).

3) Stability of the uncorrected vision during a work shift: For reasons that are not well understood, post-RK patients commonly complain that their vision becomes progressively worse later in the day. In the PERK study, 47% of the participants reported moderate-to-severe diurnal changes at one year after surgery (Schanzlin, et al., 1986). A later study found that diurnal fluctuation remained a problem even 2-4 years after surgery (Santos, et al., 1988).

   Schanzlin, et al. (1986) studied 63 of the PERK participants who complained of diurnal variation by testing their MR, Snellen acuity, and corneal shape at both 7:00-8:00 a.m. and 7:00-8:00 p.m. at one year post-op. In 42% of the participants, MR changed by -0.50 D or more from morning to evening; 24% lost at least two lines of Snellen acuity, and in 39% the cornea was observed to be significantly steeper (0.50 D or more) in the morning. The authors were surprised to find one or more of these changes in only 63% of the participants, all of whom were symptomatic. This discrepancy indicated that traditional definitions of "clinically significant" changes may be too stringent in post-RK individuals. The authors also found no significant correlation between increased minus power of the MR and decreased visual acuity. This observation is consistent with that of Rice, et al. (1985) who noted that it is very difficult to predict visual acuity based on refraction in those who have undergone RK.

In summary, it appears that diurnal variation is very common in those who have undergone RK, and that screening for this complication using traditional cutpoints for clinically significant changes has a sensitivity of only 63% (24% if only a Snellen chart is used and a two-line difference is required). For this reason, record review is essential when evaluating this potential complication in an RK candidate. Any complaints of diurnal variation reported to the candidate's private doctor can be taken as sufficient proof that this problem exists, even if not confirmed by objective testing.

4) <u>Risk of significant eye trauma</u>: RK incisions sever the stromal collagen fibrils and break their connection from limbus to limbus. Since the scars that heal the incisions do not reconnect the fibrils end to end, some authors have speculated that there may be a permanent loss of the structural integrity of the cornea. Although no formal studies of corneal rupture following RK have been conducted, there have been at least two cases of rupture during traffic accidents approximately two years after successful surgery (Schanzlin, et al., 1986). In a possibly related case, an individual complained of decreased visual acuity after being struck in both eyes during a fight (Waring, et al., 1991).

   It is unknown whether the probability of corneal rupture with trauma is significantly elevated. However, since a rupture is a catastrophic injury, hiring agencies may wish to consider the frequency with which their officers are struck in the eye before adopting standards on RK.

SUMMARY: It appears that radial keratotomy should be considered an acceptable method of visual correction for candidates, except perhaps at agencies where officers experience an extremely high number of eye traumas. However, the studies cited above support requiring RK candidates to meet the following conditions:

- All post-op records must be submitted for review;
- No significant difficulty with glare or night vision;
- Minimum deferral of 6 months post-op for candidates < 35 years old, or 12 months for those age 35 or more;
- No indication that uncorrected far acuity will be significantly degraded within the next 2-3 years by progressive hyperopia;
- No <u>significant</u> diurnal instability in visual testing or function.

A final note on RK: The above cited studies are based on surgeries performed in the early and mid-80's. Subsequent improvements in surgical techniques may result in better prognoses. Additionally, new procedures are under development and may be widely available in the near future. For example, excimer lasers are now being used to precisely "shave" and sculpture the outer layer of the cornea. In another technique, solid state lasers can create vacuoles within the stroma, and depending on their controlled collapse, change corneal shape. These new procedures may result in more predictable results and fewer complications. However, this must be demonstrated by well-designed prospective studies.

b. RECOMMENDED EVALUATION PROTOCOL

The physician must carefully question the candidate about problems regarding glare, starbursts, night vision, and diurnal variation. Dates of surgeries and any repeat procedures ("touch-ups") should be noted. All records related to the surgery and follow-up care should be obtained.

All post-RK candidates should be required to submit the results of a recent eye examination from a private vision specialist. If possible, this exam should be conducted by the same individual who tested the candidate in the past. At a minimum, testing should include measurement of uncorrected and corrected far acuity, and manifest refraction in the early a.m. and late p.m. (O.S., O.D., O.U.). The candidate's vision should meet applicable standards at all times of day. Additional testing for glare disability and contrast sensitivity should be requested, if available. Candidates with hyperopia should have their near vision tested, especially if they are in their late 30's to early 40's.

After this information is obtained, the physician should evaluate whether the candidate fulfills all of the following criteria for unrestricted duty:

- **The last surgical procedure on either eye (including touch-ups) was at least 6 months ago for candidates <35 years old, or 12 months ago for those age 35 or older.**

- **The candidate currently meets all standards for objective testing of far acuity at all times of the day** (see Far Acuity Deficiency).

- **There is no significant difficulty with glare or night vision based on review of records and history or specialized test results if available.**

- **There is no significant diurnal instability in visual testing or function.** The generally accepted criteria for significant visual instability is either a change of greater than one line (or 5 characters) of far acuity, or a change of 0.50 D (or more) in an individual's MR. However, since these objective criteria have limited sensitivity in detecting even moderate to severe diurnal fluctuation in visual function (Schanzlin, et al., 1986), documentation of complaints in medical records should be given greater weight than the results of current testing.

- **Uncorrected far acuity will not deteriorate below acceptable standards within the next 2-3 years due to progressive hyperopia.** The physician can estimate the projected MR in 2-3 years by using measurements of the candidate's MR at a minimum of two points in time (three points are preferable) and assuming a straight-line function. Table XI-13 can be used to convert this projected MR into approximate far acuity.

Example: A 35 year-old candidate had RK in January, 1992. In the immediate post-RK period, he was undercorrected, but at six months post-op, his MR was [+0.25]. At twelve months post-RK, his MR was [+1.25] with an acuity of 20/20. The evaluating physician concludes that the candidate has progressive hyperopia, since a change in MR of 0.50 D or more has been documented. At this rate of change (+1.00 D/6 months), the physician estimates that the candidate's MR could potentially "overcorrect" to a level of [+4.25] to [+6.25] in the next 2-3 years. This level of hyperopia would likely correspond to an uncorrected far acuity of between 20/70 to > 20/200. If the hiring agency had an uncorrected standard of 20/40, it would be concluded that the candidate has a condition which is likely to cause significant impairment in the immediate future. However, the candidate is encouraged to seek a re-evaluation in six months. At that time, the physician would be able to reassess the progression of the hyperopia. If it has slowed significantly, the physician may be able to deem the candidate acceptable.

Note: Caution must be exercised when using these estimates, since there is approximately a five line variation in far visual acuity for a given refraction in those who have undergone RK (Rice, et al., 1985).

Candidates with unsuccessful RK who wish to apply for an SCL waiver should be evaluated using the agency standards for both RK and SCL use. Specific examination for neovascularization of the incisional scars should also be conducted. Vascularization of one or more scars for at least 25% of its length is considered significant (Waring, et al., 1991), and probably a contraindication to continued SCL use. Progressive hyperopia should also be considered a contraindication to SCL use, since this condition may be exacerbated by SCLs (Edwards & Schaefer, 1987).

3) VISUAL FIELD DEFICIENCY

a. GENERAL CONSIDERATIONS

Partial loss of visual field in one or both eyes affects about 3% of the population between the ages of 16 to 60 (Johnson & Keltner, 1983). The incidence rate increases to about 6% between the ages of 61 to 65, and to 13% in persons over the age of 65. A large number of eye conditions can cause loss of visual field, the most common being glaucoma.

The 1984 POST vision survey indicated that peripheral vision is one of the most important visual abilities for safe patrol officer performance (Table XI-1). Examples of critical situations in which peripheral vision would be important include:

- a suspect approaching the officer from the far right or left side;
- a hostile crowd surrounding an officer;
- an officer attempting to look out of the side of a patrol car to spot a suspect while still controlling the vehicle;
- driving under emergency conditions.

Several studies have examined the performance of persons with visual field defects in situations similar to those cited above. Johnson, et al. (1992) tested the impact of glasses that restrict peripheral vision on the ability of a correctional officer to detect suspicious behavior by inmates gathered in a day room. Restricting the binocular horizontal field to 120 degrees in each eye had no impact, but further restriction to 60 degrees significantly impaired performance.

Visual Field Defects in Both Eyes. Although research conducted in the 1960's and 1970's failed to show any relationship between visual field loss and driving safety, more recent studies using better testing techniques have yielded different results. Johnson and Keltner (1983) found that accident and conviction rates of drivers with visual field loss in both eyes were more than twice as high as those with normal visual fields. This finding is consistent with a study by Hedin and Lovsund (1987) who tested individuals with driving simulators. He found that 85% of 27 patients with a variety of field defects had significantly decreased reaction times to stimuli presented in visual areas of relevance to traffic safety. Even though participants were free to move their heads during testing, only 4 (15%) could compensate for their field defects. The Federal Department of Trans-portation currently requires commercial drivers to have a horizontal field of at least 140 degrees.

Visual Field Defects in One Eye. Johnson and Keltner (1983) found slightly, but not significantly higher accident rates among drivers with unilateral field defects or monocularity. However, these drivers' visual defects were rated as severe in only 13% of the drivers with unilateral defects. The results of studies that have focused on monocular drivers or those with gross reductions of the visual field on one side have generally been significant. Kite and King (1961) observed a seven-fold increase in intersection crashes and pedestrian injuries. Keeney (1968) found that monocularity was four times more common in those cited for multiple driving violations. Moreover, a pathology study found long-standing ocular lesions on the same side as seven fatal injuries in two drivers and five pedestrians killed in Maryland (Freytag & Sachs, 1969).

SUMMARY: The evidence indicates that **the presence of either monocularity or significant bilateral field defects in a patrol officer would create a direct threat of harm to self or others. Significant field defects would include cases in which horizontal binocular field is restricted to < 120 degrees in each eye, total vertical field is less than 100 degrees, or when large scotomas are present.**

It is relevant to note that similar peripheral vision standards were upheld in a 1988 case heard by the California Fair Employment and Housing Commission involving a monocular police officer candidate (DFEH v. City of Merced PD, FEP85-86, 88-20). In finding for the city, the Commission agreed that "peripheral vision is among the most important visual abilities that a police officer needs to safely fulfill his or her duties," and that safety concerns were not mitigated by that candidate's seven years of prior experience as a patrol officer.

b. RECOMMENDED EVALUATION PROTOCOL

Due to their low sensitivity and specificity, pre-employment screening techniques for visual field defects cannot be recommended for routine testing. Clinical confrontation field testing has been shown to have a sensitivity of only 50% (Johnson & Baloh, 1991). Therefore, reliable detection of a visual field defect requires formal perimetry testing by a vision specialist, which would be expensive to administer to all candidates.

An alternative approach is to require formal perimetry testing only for candidates at high risk. This would include candidates with either a personal or family history of glaucoma, any eye problem other than refractive error, or decreased visual acuity (worse than 20/40) in either eye which cannot be corrected with lenses.

Candidates with monocular vision, <120 degrees of total horizontal field in each eye, <100 degrees of vertical field, or significant scotoma would create a direct threat of harm as patrol officers, and therefore should be restricted from field duty.

4) <u>BINOCULAR FUSION DEFICIENCY</u>

a. GENERAL CONSIDERATIONS

Normal binocular vision requires that both eyes be focused or fused on the same point in space. A strabismus is said to exist when the eyes are directed at different points. The resulting diplopia and visual confusion become the stimuli for suppression of the deviated eye, and if not treated at a young age, can result in permanent loss of vision in the deviated eye (amblyopia). The eye may be intermittently or constantly turned inward (esotropia), outward (exotropia), or even vertically deviated (hypertropia). Strabismus is observed in about 6-7% of children.

Stereopsis, which is a component of binocular fusion, is necessary for depth perception--an important visual ability for patrol officers (Table XI-1). Job-related tasks that involve stereopsis can include subduing combative suspects, driving, weapon loading under emergency conditions, and other tasks requiring judgement of the relative depth and location of objects, especially objects situated within 20 feet of the officer. It should be noted, however, that depth perception is possible using monocular cues only (Von Noorden, 1990). These cues include motion parallax (further objects move more than closer objects with head or eye motion), linear perspective (distant objects are smaller), the overlay of contours, the distribution of highlights and shadows, and the size of known objects (bigger means closer). What is not known, however, is the effectiveness of these cues in stressful situations. Using monocular cues involves judgement based on experience, and the cues must be present in abundance. Consequently, errors are possible.

Experimental studies involving individuals tested with one eye occluded have also found that adequate binocular fusion provides a "binocular summation" advantage for performing a number of tasks relevant to police work. For example, Jones and Lee (1981) found that detecting a camouflaged object required 55% longer when one eye was occluded. Tracking a moving target was 22% more efficient with both eyes open. Lack of balance, as measured by body sway when one foot is placed in front of another, was 38% greater with one eye closed. Jones and Lee also found that monocular impairment was somewhat greater in dim light. This latter finding is consistent with a study by Groome and Johnson (1993) who observed that individuals could detect an approaching pedestrian in simulated fog conditions 12% more quickly with both eyes open, and especially by Rabin (1994) who found that binocular summation provides an increase in contrast sensitivity of approximately 40%.

There are no functional studies involving individuals with permanent loss of binocular fusion; therefore, the question of the degree to which experience can compensate for this visual defect remains largely unanswered. Sheedy, et al. (1986) addressed this issue experimentally by having individuals with normal

stereopsis undergo binocular occlusion for a period of five days. He found that monocular performance of three visual-motor tasks (placing pointers into straws, needle-threading, and card filing) significantly improved with practice over the five day period; the binocular advantage in performing these tasks decreased from an average of 18% to 12.4% by the end of the five-day period for the pointers and straws and the needle-threading tasks. However, binocular performance remained better than monocular performance throughout the duration of the study.

SUMMARY: Loss of binocular fusion could potentially impair the performance of essential patrol officer duties, although it is not entirely clear to what extent persons with long-standing loss of fusion can compensate for this impairment. Therefore, although further research is needed, there appears to be evidence for requiring candidates to have a minimum degree of binocular fusion and stereopsis of approximately 40 seconds of arc.

b. RECOMMENDED EVALUATION PROTOCOL

Normal binocular vision is considered 20 seconds of arc or better, which corresponds to achieving correct responses on all 9 Titmus Stereo Test targets. However, given the uncertainty regarding compensatory mechanisms in individuals with binocular fusion deficiencies, the recommended criterion for passing is 40 seconds of arc, or dot #6.

Candidates who initially test at greater than 40 seconds of arc should be evaluated by their private vision specialist to establish the reason for the deficit if it is not readily apparent. In some cases, correction of near vision may enable the candidate to pass the Titmus test. However, it is not uncommon for a candidate to test poorly for no apparent reason (i.e., no amblyopia, strabismus, or phoria). In these cases, it is recommended that judgment be used in the interpretation of Titmus test results.

5) COLOR VISION DEFICIENCY

a. GENERAL CONSIDERATIONS

- Relevance to Patrol Officer Duties:

In the 1984 POST vision study, incumbent officers rated color identification as being "important" to "very important" (Table XI-1). Color vision was cited as being involved in an estimated 6% of critical incidents. Steward & Cole (1989) found that the most common critical incidents cited by patrol officers that require color vision involve the identification of vehicles and clothing (Table XI-14).

TABLE XI-14
Breakdown of Critical Incidents Involving Color Identification

Object	N
Vehicle	46
Suspect clothing	16
License plate	3
Container	2
Traffic light	1
Residence	1

From Steward, J.M. & Cole, B.L. 1989. What do color vision defectives say about everyday tasks? Optom. Vis. Sci. 66(5):288-295.

Color identification, especially of cars and clothing, is an important component of almost all patrol officer communications. For example, when someone calls 911 and reports a suspect or vehicle, the dispatcher generally asks the caller to describe identifying colors. The subsequent radio call to a patrol car includes this information.

In many jurisdictions, patrol officers must be able to write legal reports and testify in court regarding their observations. A jury would likely discredit the information from a color vision deficient (CVD) officer who is uncertain as to whether he saw a green car or a brown car leaving the scene of a crime, or whether a suspect had a tan or pink shirt.

Beyond color identification, color vision is also important in the recognition of signal illumination. Questionnaire results document that many CVD persons have difficulty distinguishing the color of traffic signal lights, confuse traffic lights with street lights, and have trouble seeing brake lights on cars (Table XI-15; Steward & Cole, 1989). Although it has not been shown that CVD drivers have higher total accident rates (Verriest, et al., 1980; Norman, 1980), CVD drivers appear to have relatively more accidents on road crossings controlled by traffic lights, more rear-end collisions caused by overlooking red rear, stop or warning lights, and more accidents in wet or slippery conditions (Verriest, et al., 1980).

TABLE XI-15
Percentage of Candidates Reporting Difficulty With Color When Driving

Question	Dichromats (N=37)	Anomalous Trichromats (N=65)	Color Normals (N=102)
Have you ever had difficulty distinguishing the color of traffic signal lights?	49**	18*	0
Do you ever confuse traffic lights with street lights?	33	31	2
Do you find brake lights on other cars difficult to see?	22	8	0
Do you find hazard or warning lights on temporary barricades difficult to see?	11	2	0
Do you find dashboard warning lights hard to see?	14	5	0
Do you find some road signs such as those on freeways or school crossings difficult to read?	5	11	0

Significant difference at $*p < 0.05$ or at $**p < 0.01$ using Yates x^2.

From Steward, J.M. & Cole, B.L. 1989. What do color vision defectives say about everyday tasks? Optom. Vis. Sci. 66(5):288-295.

- Classification of Color Vision Deficiencies:

The human eye has three different classes of cone photoreceptors, each with a unique photopigment that preferentially absorbs different wavelengths of light (red, green, and blue). The major classification of CVD depends on whether there is either: (1) an alteration of one of these pigments ("anomalous trichromats"); or (2) in worse cases, a total absence of a pigment ("dichromats"). CVD is further subclassified on the basis of which pigment is involved. "Protans" have a red receptor deficiency, "deutans" have a green receptor deficiency, and "tritans" have a blue receptor deficiency (Table XI-16).

For the vast majority of candidates with CVD, the condition will be of hereditary origin. However, CVD can be secondary to ocular/systemic disease (such as diabetes and glaucoma) or medications (Table XI-17). Clinical characteristics which suggest acquired CVD are presented in Table XI-18 (Bailey, 1991).

TABLE XI-16
Nomenclature, Classification, and Prevalence in Males (Females) of Different Types of Human Color Vision

Type		Percentage
Trichromatic		
Normal		92 (99.6)
Anomalous		
Protan (protanomalous)	Red-green	1 (0.01)
Deutan (deuteranomalous)	Red-green	5 (0.25)
Tritan (tritanomalous)	Blue-yellow	Trace
Dichromatic		
Protan (protanopia)	Red-green	1 (0.01)
Deutan (deuteranopia)	Red-green	1 (0.01)
Tritan (tritanopia)	Blue-yellow	0.002
Monochromatic		
S, M, or L cone (incomplete or atypical achromasy)		0.000001
Rod (typical achromasy)		0.003

From Bailey, J.E. Color vision. Chapter 13 In: Clinical Procedures in Optometry. J.B. Eskridge, J.F. Amos, J.D. Bartlett (eds). Lippincott, pp. 99-120, 1991.

TABLE XI-17
Examples of Some Commonly Prescribed Drugs Classified According to Color Deficiencies They Reportedly Induce

Blue Defect	Red-Green Defect
Chloroquine	MAO-inhibitors
Indomethacin	Chloramphenicol
Phenothiazine	Oral contraceptives
Methimazole	Ethambutol
Trimethadione	Digoxin

From Bailey, J.E. Color vision. Chapter 13 In: Clinical Procedures in Optometry. J.B. Eskridge, J.F. Amos, J.D. Bartlett (eds). Lippincott, pp. 99-120, 1991.

TABLE XI-18
Clinically Distinguishable Differences Between Acquired and Hereditary Color Vision Defects

Hereditary	Acquired
Always bilateral and equal	Usually more severe in one eye, often unilateral
Almost always a red-green deficiency; much more prevalent in males	Predominantly blue-yellow defects; males and females equally susceptible; can combine with hereditary defect
Other visual functions not affected	May affect visual acuity, visual fields, and other vision functions
Stable throughout life	Color vision varies with status of underlying condition; more stable if long-standing
Unambiguous color confusions on color vision tests	Often no clear-cut types of errors

From Bailey, J.E. Color vision. Chapter 13 In: Clinical Procedures in Optometry. J.B. Eskridge, J.F. Amos, J.D. Bartlett (eds). Lippincott, pp. 99-120, 1991.

- Assessing Functional Abilities:

The diagnostic classification of a CVD person has only limited usefulness in assessing functional capacities. About all that can be concluded is:

1) Persons who completely lack a pigment (dichromats) have more difficulty than those who have only a photopigment anomaly (anomalous trichromats); and

2) Protans appear to have more difficulty with driving than deutans (Verriest, et al., 1980; Cole & Vingrys, 1982).

Beyond these generalities, there exists a wide range of functional capacity among individuals within and between all classification groups. Consequently, the primary focus of most color vision tests is to individually assess functional capacity rather than to classify an individual's specific deficiency. The common tests include the following:

Pseudoisochromatic Plates (PIP): These tests require an individual to identify a number consisting of colored dots embedded in a background of different colored dots. The most common PIP test is the Ishihara test which consists of 15 plates. These tests are very good for quickly and accurately differentiating color "normals" from color "abnormals." One can reasonably conclude that the vast majority of persons who pass this test will not have any functional deficits. Unfortunately, 8% of male candidates will not pass this test. Assessing the functional ability of these individuals requires further testing.

Lantern Tests: These tests (such as the Farnsworth Lantern test) require the identification of small colored lights. They are commonly used to certify pilots and ship captains (Hackman & Holtzman, 1992). Some authors have advocated their use in determining whether CVD individuals should be allowed to drive commercially (Cole, 1991). However, the availability of testing equipment is extremely limited. Problems also exist with the establishment of pass-fail criteria for these tests.

Color Arrangement Tests: These tests require the individual to place colored samples (usually in the form of paper disks mounted in caps) in a logical color sequence. The most commonly used test is the Farnsworth D-15, which uses 15 caps. The advantages of this test are that it is well-standardized, readily available, inexpensive, relatively easy to administer and score, and has a high specificity. In fact, all or essentially all persons who fail the D-15 will have an impaired ability to name or distinguish differences in colors. The D-15 can also serve as relatively good substitute for a Lantern test in evaluating driving safety. Hackman and Holtzman (1992) found that 354 of 377 persons who passed the D-15 also passed the Farnsworth Lantern, while all 23 persons who failed the D-15 also failed the Lantern test.

The major limitation of the D-15 is its low sensitivity. For example, a POST color vision study (1984) demonstrated that a significant proportion of CVD persons who pass the D-15 test will still have some degree of functional deficit of relevance to patrol officer duties. A color simulation test was conducted in which participants were shown slides and asked to name the colors of specific vehicles, suspects' clothing, traffic lights, license plates, and to determine whether vehicles' brake lights were on or off. The results indicated that persons who failed both the Ishihara test and the D-15 made significantly more errors than color normals in most color naming and all driving related color-dependent tasks (Table XI-19). Those who failed the Ishihara but passed the D-15 made fewer errors on all tasks than those who failed both tests; however, their error rate was almost twice that of color normals when naming the color of cars, and almost three times that of color normals when naming the color of clothing.

The results of the POST study are corroborated by experience at other institutions. At the U.C. Berkeley School of Optometry, it has been observed that some individuals who receive a borderline pass on the D-15 test have difficulty naming some pastel colors (Zisman & Adams, 1985). At the City of Los Angeles, candidates who pass the D-15 are asked to name colors from a paint catalog. Those who make errors on the paint test are taken outside and asked to identify the colors of approximately 25-40 common objects such as cars, clothes, and houses. Among twenty-four consecutive candidates tested, thirteen individuals (54%) have made more than 1 color-naming error; six of these candidates (25%) misidentified 8 objects or more within a testing period of approximately thirty minutes (Goldberg, 1994).

TABLE XI-19
POST Color Simulation Test Results

Color-Dependent Task	Color Normals (n=19)	Fail Ishihara Pass D-15 (n=6)	Fail Both Tests (n=6)
	Number of Slides Misidentified		
Color Naming:			
Vehicles (20)*	4.7	8.9**	11.0**
Clothing (11)	1.0	2.7**	5 .8**
License plate (5)	1.8	1.4	2.5
Driving-Related:			
Brake lights (24)	2.7	1.8	7.4**
Traffic lights (20)	0.8	1.3	5.4**

*Total number of simulation slides; average number identified incorrectly is shown in table
**Significantly worse than normals by t-test

More complex and difficult color arrangement tests than the D-15 are available. The Farnsworth Munsell 100 Hue test, for example, can quantitatively score an individual's color aptitude. However, this test is normally used to demonstrate superior color aptitude among color normals rather than predict functional problems among those with color deficiencies. In addition, the test takes 45-60 minutes to administer and score.

<u>Color Naming Tests</u>: Color-naming tests offer the most content validity of any color vision test, since they directly assess a job skill. Unfortunately, the only commercially available color-naming test is the Dvorine test, which consists of a color wheel with just sixteen colors. The low number of colors limits the sensitivity of this test, and pass-fail criteria are not established. To increase sensitivity, the City of Los Angeles developed a color naming test in which candidates are asked to identify colors from an industrial paint catalog containing 120 colors. Although there are no strict pass-fail criteria, responses are compared to those of a group of 20 normal controls. Candidates are considered to be impaired if they demonstrate consistent and frequent errors. In borderline cases, the candidate is taken outside and asked to rapidly identify the colors of parked or passing cars and the colors of clothing worn by various pedestrians.

Although the addition of a color-naming test can improve the sensitivity of color vision assessment, the test's positive predictive value (i.e., the percent of individuals who fail the test and who truly have a functional problem) depends on how strictly the test is interpreted. <u>It is imperative that the test results of CVD candidates be standardized against the responses of color normals</u>. It is not uncommon for color normals to give varying responses to shades of certain colors.

SUMMARY: Patrol officers require adequate color vision in order to identify cars, clothing and other items, as well as to detect and distinguish traffic lights, street lights, and related highway lights. However, those with mild color vision deficiencies have been found to have sufficient color identification and discriminatorial skills to perform as a patrol officer. **Therefore, candidates who fail the PIP test should be administered the Farnsworth D-15. Those who fail the D-15 should be restricted from field duty requiring color identification and discrimination.**

The sensitivity of the D-15 can be improved by requiring additional testing of color-naming abilities. However, due to problems with standardization in test administration and score interpretation, use of in-house color naming tests is not recommended for most agencies.

- Corrective Lenses:

Some optometrists or physicians will dispense a rose-colored contact lens ("X-Chrom" lens) to persons with CVD. When worn in one eye, the lens will allow a person to pass a pseudoisochromatic plate test because the lens introduces a brightness difference between the figure and the background. The effect is equivalent to looking at the plates through a red filter and violates the basic illumination requirements for the test. In fact, Matsumoto, et al. (1983) found that performance on other color vision tests may be worse, discrimination of colors not previously confused may be poorer, and stereopsis impaired.

b. RECOMMENDED EVALUATION PROTOCOL

Candidates who fail the screening PIP test should undergo a detailed history and be administered a Farnsworth D-15 test.

HISTORY - An excellent set of questions can be found in Tables XI-15 and XI-20. Any admission by the candidate of color vision problems will lend support to a decision to assign job restrictions. However, a failure to acknowledge problems does not negate the findings of objective testing. A recent study found that 5% of dichromats and 25% of anomalous trichromats were not aware of their CVD (Steward & Cole, 1989). In certain cases, the physician may want to consider whether the CVD is non-hereditary and potentially reversible (see Tables XI-17 & XI-18). This is especially important if the CVD candidate is taking medication, female, or if the deficiency follows a tritanopic pattern.

D-15 TEST - Illumination is critical for this test and should be equivalent to that used for the PIP test (see Routine Testing - Color). The D-15 test should be illuminated from above at an angle of about 90°, and the viewing angle should be at about 60°. After opening the box containing the colored caps, the loose caps should be removed from the tray, placed in front of it, and then intermixed. Candidates should be observed during testing and should not be allowed to pre-sort the caps before placement in the testing tray.

The following set of instructions to the candidate is recommended: "Select the cap that looks most like this fixed cap (point to D-15 panel "pilot" cap) and place it next to it. Next, select from the remaining loose caps the one most like the cap you just placed in the tray and put it next to that one. Continue until all the caps are in the box. You may rearrange the caps, if you wish, so that a regular series is formed between the end caps."

Candidates should be allowed as much time as necessary to complete the test; however, it is helpful to suggest a time limit.

The conventional criteria for failing is two or more major crossings in approximately the same direction on the scoring diagram (see Figures XI-7 - XI-13). A major crossing requires that caps be placed at least four numbers apart, as would occur if cap 7 were placed next to 11. Normal patterns include no errors, or patterns in which caps are arranged in reverse order following a crossing (see Figures XI-7, XI-8, and XI-9). Candidates who fail the test should be allowed to immediately repeat it. The results should be fairly reproducible.

Candidates who consistently fail the D-15 and whose impairment is not reversible should not be permitted to perform tasks that require rapid and accurate color identification, nor allowed to engage in high-speed emergency driving.

TABLE XI-20
Percentage of Individuals Reporting Difficulty With Everyday Tasks That Involve Color

Question	Dichromats (N=37)	Anomalous Trichromats (N=65)	Color Normals (N=102)
Have you ever had any difficulty in selecting the colors of clothes, accessories, cars, paints, carpets, furniture, wallpaper, or cosmetics?	86**	66*	0
With craft work and hobbies, do you have any trouble distinguishing the colors of wires, threads, materials, wools, paints, or other things?	68***	23***	0
Do you find plant or flower identification difficult because of color?	57***	18***	0
Do you have any difficulty determining when fruits and vegetables are ripe by their color?	41*	22*	0
Can you determine if meat is cooked by its color?	35*	17*	0
Do you have any difficulties because of color as either a spectator or participant in sporting activities?	32	18	0
Do you find it difficult to adjust the color balance on a color TV satisfactorily?	27	18	2
Have you ever had difficulty in recognizing skin conditions such as sunburn and rashes?	27	11	0
Have you ever taken the wrong tablet or medicine because of difficulties with its color?	0	3	0

Significant difference between dichromats and anomalous trichromats at $^{*}p < 0.05$ or at $^{***}p < 0.002$ using Yates x^2.

From Steward, J.M. & Cole, B.L. 1989. What do color vision defectives say about everyday tasks? Optom. Vis. Sci. 66(5):288-295.

FIGURES XI-7 -- XI-13 Normal and Color Defective Response Patterns on the Farnsworth D-15

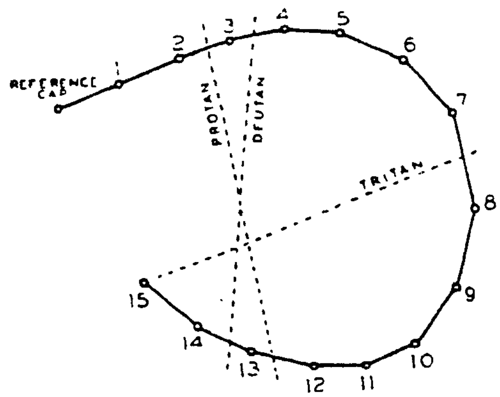


Figure XI-7 -- Normal Vision -- No Errors

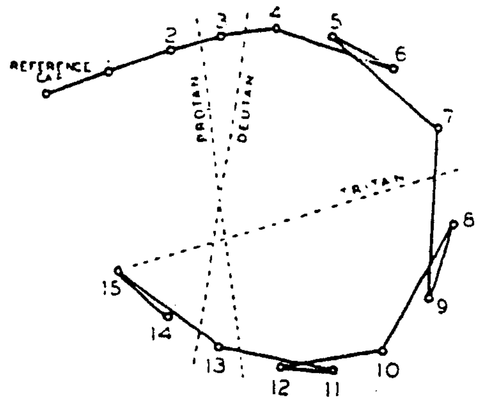


Figure XI-8 -- Normal Vision -- Minor Errors

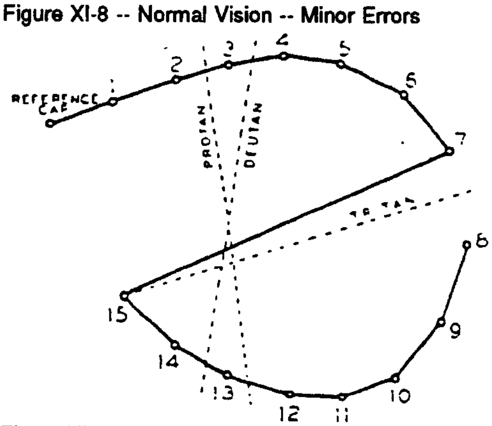


Figure XI-9 -- Normal Vision -- One Error (See Text)

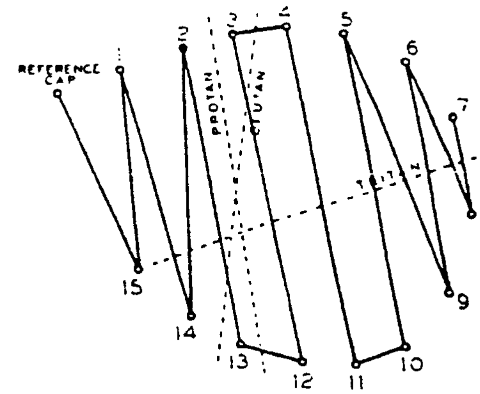


Figure XI-10 -- Defective Vision -- Red Blindness (Protanopia)

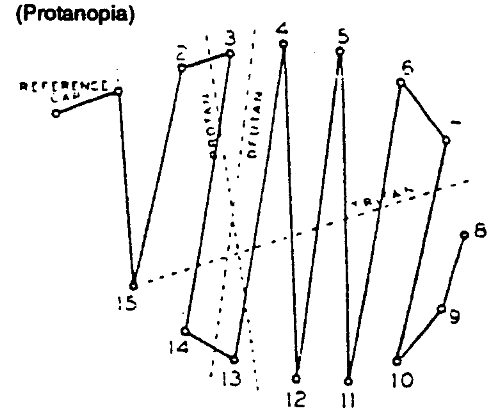


Figure XI-11 -- Defective Vision -- Green Blindness (Deuteranopia)

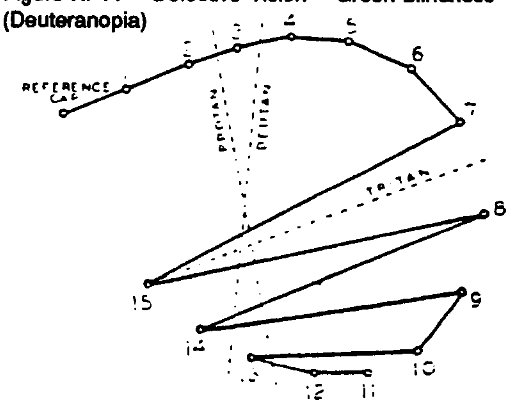


Figure XI-12 -- Defective Vision -- Blue Blindness (Tritanopia)

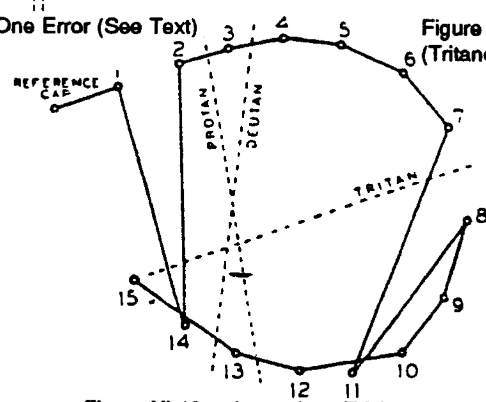


Figure XI-13 -- Anomalous Trichromatic Vision

From Farnsworth, Dean. 1947. The Farnsworth dichotomous test for color blindness panel D-15 manual. Psychological Corporation, NY.

SUMMARY OF VISION GUIDELINES

The vision guidelines are briefly summarized below. However, before using these guidelines in the development of agency-specific vision standards, it is important to read the discussions of these issues found in the respective sections. Page numbers where these discussions are located are indicated in parentheses.

1. **FAR ACUITY** (XI-8 - XI-37)

Corrected Vision: (XI-8 - XI-14)

- Best corrected vision of 20/20.
- Best corrected vision should be assessed for **both** eyes together.

Use of Glasses: (XI-15 - XI-23)

- Due to the likelihood of dislodgement or breakage, candidates who wear glasses should meet an uncorrected far acuity standard of between 20/40 - 20/100. The exact far acuity standard selected should be based on agency-specific considerations such as:
    - The likelihood and circumstances surrounding the use of firearms at that agency (e.g., distances of targets, frequency of foot pursuits in conjunction with weapon use)
    - The likelihood of engaging in combative situations
    - Deployment of one officer patrol units
    - Inclement weather, night shift duty, and other environmental conditions that may affect visibility with glasses

Use of Contact Lenses: (XI-23 - XI-29)

- Use of soft contact lenses (SCLs) is permissible by candidates who have at least one year of successful SCL use, and provided that the agency uses pre-placement agreements and has a monitoring program in place.
- SCL use is preferred over the use of other types of contact lenses (i.e., rigid gas permeable or hard lenses) due to concerns of particle entrapment and dislodgement.
- The establishment of an uncorrected vision standard for SCL wearers should be an agency-specific risk management decision. However, should an agency decide to create an uncorrected standard, it is recommended that it be no more stringent than 20/200 (both eyes).

Use of Orthokeratology: (XI-30 - XI-31)

- Due to concerns over fluctuating vision, particle entrapment, and the inability to monitor compliance, the use of SCLs are preferred over ortho-K lenses. At a minimum, ortho-K wearers should be required to always wear lenses on duty and meet all requirements established for contact lens wearers.

Evaluation Protocol: (XI-32 - XI-37)

2) RADIAL KERATOTOMY (XI-38 - XI-42)

- All post-op records must be submitted for review.

- No significant difficulty with glare or night vision.

- Minimum deferral of 6 months post-op for candidates < 35 years old, or 12 months for those age 35 or more.

- No indications that uncorrected far acuity will be significantly degraded within the next 2-3 years by progressive hyperopia.

- No significant diurnal instability in visual testing or function.

3) VISUAL FIELD DEFICIENCY (XI-43 - XI-44)

- Formal perimetry testing should only be conducted on high risk candidates, such as those with either a personal or family history of glaucoma, eye problems other than refractive error, or decreased visual acuity in either eye which cannot be corrected with lenses.

- The results of those who undergo formal perimetry should indicate:

    - A minimum of 120 degrees of total horizontal field in each eye.
    - At least 100 degrees of vertical field.
    - No significant scotomas.

4) BINOCULAR FUSION DEFICIENCY (XI-45 - XI-46)

- Candidates should demonstrate a minimum stereopsis of at least 40" of arc by achieving a score of 6 or better on the Titmus Stereo Test.

5) COLOR VISION DEFICIENCY (XI-47 - XI-56)

- Candidates who fail the PIP test should be required to pass the Farnsworth D-15.

- Use of rose-colored lenses (i.e., "X-Chrom") should not be permitted during testing.

REFERENCES

American Optometric Association (AOA). 1990. Guidelines for the use of contact lenses in industrial environments (position paper). Alexandria, VA.

ANSI Z80.21. 1992. American National Standard for General Purpose Visual Acuity Charts. Merrifield, VA: Optical Laboratories Assoc.

Atkin, A., et al. 1986. Radial keratotomy and glare effects on contrast sensitivity. Doc Ophthalmol. 62:129-148.

Bailey, J.E. 1991. Color vision. Chap. 13 in Clin Procedures in Optom, eds. J.B. Eskridge, J.F. Amos and J.D. Bartlett. pp.99-120. Philadephia: J.B. Lippincott.

Bible, M. 1993. Unpublished data. City of Los Angeles, Personnel Dept.

Binder, P.S. 1983. Myopic extended wear with the hydrocurve II soft contact lens. Ophthalmol. 90(6):623-626.

Borish, I.M. 1970. Visual Acuity. Clinical Refraction, 3rd ed. MA: Butterworth-Heinemann.

Briggs, R. 1984. Visual skills job analysis and automated vision testing. Unpublished technical report for Commission on Peace Officer Standards and Training.

Broome, P.W. and Classe, J.G. 1979. Long-term success in contact lens wear. Contact Lens Forum. (September):15-27.

Bullimore, M.A., Bailey, I.L. and Wacker, R.T. 1991. Face recognition in age-related maculopathy. Invest Ophthalmol Vis Sci. 32:2020-2029.

Cole, B.L. 1991. Does Defective Colour Vision Really Matter? Proc Int Res Group on Colour Vision Deficiences. (June) Sidney, Australia.

Cole, B.L. and Vingrys, A. 1982. Do Protanomals Have Difficulty Seeing Red Lights? Proc 20th Session CIE Pub. No. 56:1-3.

Cross, J.F., Cross, J. and Daly, J. 1971. Sex, race, age, and beauty as factors in recognition of faces. Perception and Psychophysics. 10:393-396.

Deitz, M.R., et al. 1986. Progressive hyperopia in radial keratotomy. Ophthalmol. 93:1284-1289.

Dodson, S.R. 1993. Sighting-in on visual acuity. Law and Order. (June):54-58.

Edwards, G.A. and Schaefer, K.M. 1987. Corneal flattening associated with daily wear soft contact lenses following radial keratotomy. J Refract Surg. 3(2):54-58.

Ellis H.D., et al. 1973. The effects of age and sex upon adolescents' recognition of faces. J Gen Psychol. 123:173.

Ferris, F.L., et al. 1982. New Visual Acuity Charts for Clinical Research. Amer J Ophthalmol. 94:91-96.

Freytag, E. and Sachs, J.C. 1969. Abnormalites of the central visual pathways contributing to seven Maryland traffic accidents. JAMA. 204:119.

Giannoni, B. 1981. Entry-Level Vision Requirements Validation Study. Personnel Bureau, California Highway Patrol.

Goldberg, R.L. 1993. Eye injuries among LAPD field officers, 1987-1990. Unpublished data.

Goldberg, R.L. 1994. Field testing of LAPD applicants who pass the D-15. Unpublished data.

Goldberg, R.L. and Bible, M. 1993. Visual testing of incumbent firefighters in the LAFD. Unpublished data.

Good, G.W. and Augsburger, A.R. 1987. Uncorrected visual acuity standards for police applicants. J Police Sci Admin. 15(1):18-23.

Groome, W.R. and Johnson, C.A. 1993. Final report on entry level drawbridge operator vision standard for the California Department of Transportation.

Hackman, R.J. and Holtzman, G.L. 1992. Color vision testing for the U.S. Naval Academy. Military Med. 157(12):651-657.

Hedin, A. and Lovsund, P. 1987. Effects of visual field defects on driving performance. Documenta Ophthalmol Proc Series. 49:541-547.

Holden, R.N. 1984. Vision standards for law enforcement: A descriptive study. J Police Sci Admin. 12:125-129.

Holden, R.N. 1993. Eyesight standards - correcting myths. FBI Law Enforcement Bulletin. (June):1-6.

Johnson, C.A., et al. 1992. Entry-level correctional officer vision standards. Calif. Dept. of Corrections.

Johnson, C.A. and Brintz, N. 1993. Entry Level Vision Standards for Group Supervisors and Youth Counselors (draft). Sacramento: California Dept. of Youth Authority.

Johnson, C.A and Keltner, J.L. 1983. Incidence of visual field loss in 20,000 eyes and its relationship to driving performance. Archives Ophthalmol. 101:371-375.

Johnson, L.N. and Baloh, F.G. 1991. The accuracy of confrontation visual field test in comparison with automated perimetry. (Vol.83) J Ntl Med Assoc. 10:895-898.

Jones, R.K. and Lee, D.N. 1981. Why two eyes are better than one: The two views of binocular vision. J Exp Psych Human Perception Perf. 7(1):30-40.

Keeney, A.H. 1968. Ophthalmic pathology in driver limitation. Trans Am Acad Ophthalmol Otolaryngol. 72:737.

Key, J.E. 1990. Are hard lenses superior to soft? Cornea. 9(Suppl 1):S9-11.

Kirn, T.F. 1987. As number of contact lens users increases, research seeks to determine risk factors, how best to prevent potential eye infections. JAMA. 258(1):17-18.

Kite, C.R. and King, J.N. 1961. A survey of the factors limiting the visual fields of motor vehicle drivers in relation to minimum visual fields and visibility standards. Br J Physiol Opt. 18:85.

Kok-van Aalphen, C.C., et al. 1985. Protection of the police against tear gas with soft lenses. Military Med. 150:451-454.

Mancuso, R. 1987. Survey of myopic LAPD officers. Unpublished study.

Mason, S.E. 1986. Age and gender as factors in facial recognition and identification. (Vol. 12) Experimental Aging Research. 3:151-154.

Matsumoto, E.R., et al. 1983. Effect of X-chrom lens on chromatic discrimination and stereopsis in color deficient observers. Am J Optom Physiol Opt. 60:279-302.

Milburn, H.J. and Mertens, H.W. 1993. Validation of an inexpensive test illuminant for aeromedical color vision screening. DOT/FAA/AM-93/16. Oklahoma City: FAA Civil Aeromedical Inst. NTIS.

Nilsson, S.E.G., et al. 1981. Contact lenses and mechanical trauma to the eye. Acta Ophthalmol. 59:402-408.

Nilsson, S.E.G. and Andersson, L. 1982. The use of contact lenses in environments with organic solvents, acids or alkalis. Acta Ophthalmol. 60:599-608.

Nilsson, S. and Lindh, H. 1984. Daily contact lens wear; a three-year follow-up. Acta Ophthalmol. 62:556-565.

Nilsson, S. and Persson, G. 1986. Low complication rate in extended wear contact lenses. Acta Ophthalmol. 64:88-92.

Norman, L.G. 1980. Medical aspects of road safety. Lancet. 1:1039-1045.

Pate, A. and Hamilton, E. 1991. The Big Six: Policing America's Largest Cities. Washington, D.C: The Police Foundation.

Polse, K., et al. 1990. Contact Lens Use Under Adverse Conditions - Applications in Military Aviation. Washington D.C.: National Academy Press.

POST. 1984. Color vision for patrol officers. Commission on Peace Officer Standards and Training. Unpublished study.

Rabin, J. 1994. Optical defocus: Differential effects on size and contrast recognition threshold. (Vol. 35) Invest Ophthamol Vis Sci. 2:646-648.

Rengstorff, R.H. and Black, C.J. 1974. Eye protection from contact lenses. J Am Optom Assoc. 45(3):270-276.

Rice, V., et al. 1985. Correlation of uncorrected visual acuity and cycloplegic refraction after radial keratotomy in the PERK study. ARVO Abstracts. Invest Ophthalmol Vis Sci. (Suppl.) 26:149.

Robbins, J.C. 1977. A three-year retrospective soft lens contact lens study. In Proc 2nd Natl Res Symp Soft Contact Lenses Int. Congr. Ser. No. 398:57-61. Excerpta Medica, Amsterdam.

Royall, W.W. 1977. Soft contacts and law enforcement. Contact Lens Forum. (March):15-17.

Santos, V.R., et al. 1988. Morning-to-evening change in refraction, corneal curvature, and visual acuity 2 to 4 years after radial keratotomy in the PERK study. Ophthalmol. 95(11):1487-1493.

Schanzlin, D.J., et al. 1986. Diurnal change in refraction, corneal curvature, visual acuity, and intraocular pressure after radial keratotomy in the PERK study. Ophthalmol. 93(2):167-175.

Sheedy, J.E. 1980. Police vision standards. J Police Sci Admin. 8(3):275-285.

Sheedy, J.E., et al. 1986. Monocular vs. monocular task performance. Am J Optom Physiol Optics. 63(10):839-846.

Slataper, F.J. 1950. Age norms of refraction and vision. Archives of Ophthalmol. 43:466.

Spilberg, S.W. 1993. Analysis of LAPD officer-initiated shootings by distance and time of day. Unpublished data.

Steward, J.M and Cole, B.L. 1989. What do color vision defectives say about everyday tasks? Optom Vis Sci. 66(5):288-295.

Verriest, G., et al. 1980. New investigations concerning the relationships between congenital color vision defects and road traffic security. Int Ophthalmol. 2(2):87-99.

Von Noorden, G.K. 1990. Binocular Vision & Ocular Motility: Theory & Management of Strabismus. St. Louis: Mosby Yr Bk.

Waring, G.O., et al. 1985. Changes in refraction, keratometry, and visual acuity during the first year after radial keratotomy in the PERK study. ARVO Abstracts. Invest Ophthalmol Vis Sci. (Suppl.) 26:202.

Waring, G.O., et al., 1990. Results of the prospective evaluation of radial keratotomy (PERK) study 4 years after surgery. JAMA. 263(8):1083-1091.

Waring, G.O., et al. 1991. Results of the prospective evaluation of radial keratotomy (PERK) study five years after surgery. Ophthalmol. 98(8):1164-1176.

Zisman, F. and Adams, A.J. 1985. Color Vision Screening Policy. (September 11). Berkeley: University of California, School of Optometry.